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LAND UTILIZATION IN BRITAIN

FOR well over a year public concern regarding the utilization of land in Great Britain has found repeated expression, more especially regarding the claims of the Services, but also those of the Ministry of Fuel and Power and of the various municipalities in connexion with water, power or other schemes. During 1947, in addition to the Town and Country Planning Act, which did nothing to allay concern regarding departmental claims and activities, there have been published the reports of the Hobhouse Committee on National Parks in England and Wales, the Huxley Committee on the Conservation of Nature in England and Wales, the Hobhouse Committee on Footpaths and Access to the Countryside and the Scottish National Parks Committee, under the chairmanship of Sir J. Douglas Ramsay, on National Parks and the Conservation of Nature in Scotland, as well as, more recently, that of the New Forest Committee under Mr. H. T. Baker. All these reports contain much common ground in regard to the dangers of conflict between departmental and national interest, and represent a large measure of consensus of opinion that is both responsible and authoritative.

There are as yet few, if any, signs of a disposition on the part of the Government to deal with the central issues, and to give attention to such important representations and recommendations. The official committees in the reports noted above have shown good cause for reserving for national parks about 5,680 square miles in England and Wales, and 2,000 square miles in Scotland, together with fifty-two conservation areas in England and Wales, amounting to 70,000 acres, and further conservation areas in Scotland which have yet to be specified. According to a statement by Mr. M. V. Osmond, assistant secretary of the Council for the Preservation of Rural England, at a conference in London on November 26, the total Service requirements for training areas and ranges amount to about 1,328 square miles. Of these, only 156 square miles are in Scotland, and no less than 255 square miles claimed by the Services lie in the proposed national park areas of England and Wales. Responsible leaders of the rural preservation movement clearly appreciate the reasons for the larger requirements of the Services. These needs will not be recognized as widely and as fully as they deserve, however, until the Government has made available the promised general picture of the land requirements of the Services and a statement of the principles determining the choice of sites. While choice appears to be piecemeal, there will persist the tendency, however unfounded, to regard the Services as unimaginative enemies of agriculture, amenities, archæology and the study of Nature, and resentment at departments which appear to be judges in their own cause will grow.

There is already too much evidence of the latter tendency in this as in other matters for it to be disregarded lightly by the Government, all the more because a clear lead to the decisive principles has been given by the reports already noted. The

Hobhouse Committee, in its report on national parks, in recommending that the prime charge of national parks should be given to a specific central authority, under the parliamentary responsibility of the Minister of Town and Country Planning, recognized that farming and essential rural industries must flourish unhampered by unnecessary controls or restrictions, and protected so far as possible from the inconveniences that might arise from an increased number of visitors. Other forms of large-scale development and land use, which might affect adversely natural beauty and popular enjoyment, such as water catchment, mineral extraction, military training and commercial forestry, should be accommodated in national parks only under proved national necessity, and even then the greatest care should be taken to minimize their detriment to the landscape.

To that statement no exception can be taken, nor to the Committee's reiteration that the administration of a national park must be for the benefit of the nation and by appropriate national decision and action. The doubts arise rather as to whether, under the parliamentary responsibility of the Ministry of Town and Country Planning, a national parks commission can achieve its planning objectives in the control of the use of such areas. However successful the commission may be in recruiting staff of the character and ability essential, it will need much more powerful backing than the present Ministry of Town and Country Planning has been able to offer in order to resolve the conflicts between national and local interests which may arise in some industrial development or extension of public utilities, and particularly to resist dangerous encroachments of other departments of State. The Committee itself recognizes that the major threats in the type of country envisaged for national parks arise from the activities of Government departments, and it suggests the establishment of a permanent Cabinet or ministerial committee charged with the reconciliation of all claims to the use of land by Government departments, wherever conflicts of interest prove insoluble by the ordinary means of inter-departmental consultation. That may indeed provide a solution, but only if more is done beforehand. The Minister of Defence should at least be responsible for seeing that the demands of Service departments for land are sifted and co-ordinated before they are submitted to any inter-departmental committee; and there must be an end to the practice of departmental requirements for land being formulated without reference to the Ministry of Town and Country Planning.

The Huxley Committee, in its report on the Conservation of Nature in England and Wales, was even more explicit. Within certain designated areas it recommended that further development or economic exploitation should not be begun, nor military occupation planned, before the appropriate scientific authority has been informed and given the opportunity of bringing objections before an impartial tribunal. The Committee does not claim that in these areas scientific considerations should have an overriding voice, but merely that they should be recognized as one of the interests that must be taken into account before final decisions are made upon proposals that are likely to have drastic effects upon prevailing conditions; and it points out rightly that machinery for the resolution of conflicting interests at whatever level can only be effective if the positive claim for scientific consultation in such areas is fully recognized.

It has been the Government's apparent disregard of so reasonable a claim that is responsible for much of the concern with which the question of Service lands is at present regarded. The Huxley Committee proposed that as a matter of urgency the Ministry of Town and Country Planning should communicate to all departments and public authorities concerned the list of sites recommended for preservation and should take steps to ensure that no changes in land use (or extensions of temporary war-time uses) affecting these areas should be sanctioned without the fullest investigation of their possible repercussions on Nature conservation.

The Hobhouse Committee on Footpaths and Access to the Countryside was likewise impressed with the urgency of the situation and the dangers attendant on delay. In particular, its recommendations regarding long-distance rights of way, such as the Pennine Way recommended in the Scott Report, are endangered by some of the recent claims of the Services; and the survey which it recommends should clearly be undertaken as a matter of urgency by the Ministry of Town and Country Planning. Once again, observations on conflicting interests in land are eminently reasonable; indeed, they may well be held to concede too much to water undertakings, the Forestry Commission and other special interests. It will be noted that the Committee firmly recommends that public access should be secured over all training grounds except where live ammunition is used, and that local permission should also be granted, where practicable, for public access over artillery ranges when firing is not in progress. Moreover, once again attention is directed to the necessity of arrangements to ensure that planning authorities have full opportunity of making representations, and, if desired, of being heard in regard to the effect of Service departments' proposals on public access.

The Hobhouse Committee in its report estimates the area of land required by the Service departments for training purposes in England and Wales as in the neighbourhood of a million acres, mostly uncultivated land and including much of the finest country for rambling access. Whether or not it is due to the lesser demands on such areas in Scotland, the Scottish National Parks Committee and the Scottish Wild Life Conservation Committee are much less forthright. They assume, rather than recommend, that the Secretary of State for Scotland is competent to ensure that other Government departments will consult him, as planning minister for Scotland, about any proposals of their own for development, and that it will be the normal practice for him to consult any national parks commission and park planning committee before giving any decision. They recommend, indeed, that national park areas should be treated as particular areas in which statutory

undertakings are not exempt from planning control, and that it should be obligatory on such undertakings and on Government departments to consult the national parks commission before giving approval to any development proposed in such areas. The assumption that land in such areas owned by Government departments, local authorities and statutory undertakings will be developed and administered in conformity with national park requirements, to say the least, is a little naïve and scarcely accords with recent experience.

The ideas and recommendations of these two Committees are in line with those of the National Parks Committee for England and Wales, and include the provision of the long-distance paths and of public access to all uncultivated land in a national park area, subject to suitable regulations. On water catchment areas, indeed, the Committees are disposed to be less lenient to the water undertakings than is the Hobhouse Committee. Finally, it may be noted that the New Forest Committee in its report urges that all war-time encroachments which are such a serious feature in the present condition of the Forest, including the bombing ranges, the aerodromes, the War Agricultural Executive Committee's cultivations, and a prisoner-of-war camp and stores depot, should cease at the earliest possible moment and the lands affected should be restored to their former state. Further, to ensure that scientific interests are not adversely affected by drainage, burning plantations or other changes, the whole Forest, open and enclosed, should be declared a Nature reserve.

The relevance of this particular report, apart from the similarity in its general trend, lies in the illustration it affords of the imperative necessity of immediate action to safeguard areas and amenities, some of which are unique in Britain and many of which are threatened from several quarters. It is pertinent to remind the Government that good intentions are no substitution for sound judgment and wise administration; it is also true that the feeling of frustration and exasperation which so many piecemeal proposals are engendering and spreading, in the absence of any indication of some governing policy and some overriding authority competent to resolve issues in the national interest are, like other factors in the general situation, undermining the incentive to work. The case for national parks rests at least in part on the stimulus to health which free access to unspoilt natural beauty can afford. Already measures which, on the plea of the economic crisis, the Government has imposed, have restricted the means and freedom of access to the countryside for many thousands of workers in the industrial towns of Britain. The Government has rightly called for increased effort and for longer hours of work at the present time; it cannot wisely ignore the importance of providing as fully as possible the means for enjoying those types of recreation which in a war-weary and increasingly drab and regulated world can bring spiritual as well as physical healing to jaded minds and bodies.

This aspect was strongly urged by Mr. Edward Evans in relation to the Norfolk and Suffolk Broads in a debate on the adjournment in the House of Commons on November 25. He pleaded with the Minister of Town and Country Planning to restore to the public the rights of access which were being impeded by private interests as well as by local authorities, and for measures to deal effectively with the growth of weeds and other aquatic vegetation. Mr. Evans made it clear how grave are the consequences of neglect to deal with such insidious encroachments and how important is the time factor. The Broads are one of the areas recommended for inclusion in the national parks scheme, and although the Minister of Town and Country Planning indicated that his Ministry agreed in general with the recommendations of the Broads Preservation Committee and promised a definite reply later to the points raised, the terms of his reply at least implied some doubt as to the Government's readiness to undertake legislation on the report of the National Parks Commission. If such legislation was undertaken, however, he committed the Government to the inclusion of the Broads as one of the national park areas.

Much the same arguments were urged by Mr. S. Swingler on the following day in regard to the requisitioning of parts of Cannock Chase and the question of public access to that area, 24,000 acres of which are scheduled as a conservation area for wild life. Mr. S. Swingler pointed out that while a large part of this relatively unspoiled countryside had for some time been maintained by the Forestry Commission, 1,000 acres are still retained by the Service departments and public access is denied to a much larger area. It had recently been disclosed that the Services had claims on nearly 2,000 out of the 30,000 acres; all that Mr. Swingler said about the importance of public access for the surrounding large urban areas was strongly supported by Mr. H. O. Hughes and other speakers who followed. The Parliamentary Secretary to the Ministry of Town and Country Planning, in replying, was able to dispel some anxiety as to the encroachments on Cannock Chase itself, but it still does not appear that the Government realizes the extent of public feeling or the gravamen of the criticism of piecemeal procedure.

This is one reason—a very practical and short-term one—why the prospect of much natural beauty being damaged or rendered inaccessible is so alarming at the present time. Fortunately, the position is not yet irretrievable. There have been instances of forbearance and understanding which demonstrate recognition on the part of military authorities that the love of natural beauty is a valid consideration, as tangible if not necessarily as weighty as agriculture, mining or defence; and the reports already noted bear evidence that the preservers of the countryside recognize that the Service authorities, like public undertakings, are servants of the State, carrying out to the best of their abilities the duties which their service lays upon them.

With such considerable measure of goodwill and elbow room to work in, provided only the individual proposals are not considered in isolation but in relation to other alternatives in the national picture, there should be fair prospects of general agreement between the interests involved.

QUANTUM MECHANICS

The Principles of Quantum Mechanics

By Prof. P. A. M. Dirac. (International Series of Monographs on Physics.) Third edition. Pp. xii+312. (Oxford: Clarendon Press; London: Oxford University Press, 1947.) 25s. net.

IT is now twenty years since the theory of quantum mechanics was founded, and not much less since the first edition of Dirac's book was published. Ever since, it has been a classic of scientific literature.

The importance of the development which has taken place in these twenty years can scarcely be fully gauged at present. The whole of the atomic world has been opened up for exact treatment and understanding in a way which can only be compared with the development of mechanics since Newton; and so rapid has the progress been that already large-scale practical applications of quantum mechanics have been made. Moreover, and more important still, there is no doubt that quantum mechanics implies a profound departure from the way of thinking which is characteristic of classical physics. This feature, the philosophical consequences of which are up to now scarcely fully realized, will have consequences which will perhaps make themselves felt only after a considerable time, just as the impact of exact science on European thought and life became noticeable only a long time after Newton.

The text-book literature on quantum mechanics is still in an unsatisfactory state. The much-wanted text-book, of some 1,000 pages, giving a balanced account of all the important aspects of the theory and a selection of the most typical applications, has not yet appeared. Dirac's book certainly does not profess to occupy this place. It is not a book for the student who wants to learn quantum mechanics; but no one who wishes to have a thorough insight into the subject, provided he has gained a first knowledge of it, can afford not to study Dirac's book very carefully. The condensed and crystal-clear style, characteristic of the author, makes delightful and satisfactory reading, especially for someone who (like the reviewer) thinks that this, rather than the descriptive style, is more appropriate for subjects of this kind.

The author has chosen a straight, one-line approach to the subject, and this is the more formal axiomatic approach. It is very satisfying from the logical point of view, but not, of course, the best pedagogical way to introduce a student to quantum mechanics. As in the previous editions, the first 100 pages or so are devoted to the 'framework' of quantum mechanics, that is, the general principles and properties of all those mathematical entities which occur in quantum mechanics: the eigenvectors (the word eigenfunction or wave-function does not occur until much later), linear operators, observables, etc. So, for example, the book begins with the superposition principle of states, and continues by explaining (and postulating) how the 'observables' are represented by linear operators. The principle of indeterminacy is introduced from the start. Nothing so far about dynamics and the equations of motion, which will fill the framework with physical content. All this is much in the same style as in the previous editions, except for a notable change in the notation. The author uses the 'bracket notation' (rather 'bra-c-ket' notation) which he has invented for the purpose. The well-known type of quantity $(\psi_a^* Q \psi_b)$ occurring so frequently in quantum mechanics, where ψ_a, ψ_b are the wave-functions of eigenstates a, b, and Q a linear operator, are denoted by $<a|Q|b>$. The author rightly lays emphasis on the fact that all that matters here is not what function ψ_a is, but what states a and b are and what Q is. It is also emphasized that ψ and ψ^* are never mixed up in quantum mechanics; they occur *always* after and before the operator Q, respectively, whereas the fact that ψ^* is the complex conjugate to ψ is less fundamental. This is brought out by the notation $<$ and $>$. The vectors $<a$ and $b>$ are called 'bra' and 'ket' from the word 'bracket', which describes the notation used in print. Its two syllables, one of them mutilated (for symmetry reasons, obviously) by the loss of the letter 'c', are promoted to the full rank of nouns and important mathematical and physical content is conferred upon them.

In the second third of the book the laws of quantum dynamics are developed. After an exposition of the equations of motion, the angular momentum and the spin are introduced, and a few applications to the hydrogen atom, perturbation theory and the general theory of collisions (with the important representation in momentum space) follow. Also here the main difference compared with previous editions is the notation.

In the last part of the book the many-body problem, the relativistic wave equation and the theory of radiation are treated. Here important alterations and additions are made. In the treatment of an assembly of 'bosons' ('bosons' and 'fermions' are particles obeying Bose and Fermi statistics), the elegant and powerful method of Fock is used which the author has himself applied and developed in his work since 1940. This is applied to the radiation field, that is, an assembly of photons. The author treats a photon on exactly the same footing as any other type of particle obeying Bose-statistics, which is justified in quantum theory. On the other hand, one might perhaps also mention the difference that exists between charged and neutral particles when talking of them as particles in the classical sense. In particular, it seems that photons cannot in the classical limit be considered as particles at all in the sense that a charged particle can.

The last few sections of the book contain somewhat controversial matter. In the treatment of the interaction of radiation with electrons, the author uses the λ-limiting process which was originated by Wentzel, in order to remove the infinite self-energy of a classical point-electron, and was later extended to quantum theory by the author. In reading these sections of the book, one gets the impression that the author firmly believes in this procedure as a remedy for part of the difficulties of quantum electrodynamics; whereas it is mentioned at the end of the book that, nevertheless, fundamental difficulties occur here. It might be mentioned that not all who work on this subject share the author's opinion about the physical correctness of the λ-procedure, although this is, of course, a most interesting and stimulating theory.

In the new version, as in the old ones, Dirac's book will play the part it has played before: it is the standard work in the fundamental principles of quantum mechanics, indispensable both to the advanced student and the mature research worker, who will always find it a fresh source of knowledge and stimulation.

W. HEITLER

MODERN GENETICS

Genetics

By Edgar Altenburg. Pp. xii+452. (New York: Henry Holt and Co.; London: Constable and Co., Ltd., 1946.) 16*s*. net.

THE teaching of all subjects is bound to be influenced by its object. That object ostensibly has always been to expand the mind of the pupil, accustoming it to new modes of thought and to their application in practice. For such a purpose the new development of the science of genetics is remarkably well suited. All types of scientific method have been used in this development and all aspects of human life and thought are affected by its practical application. The only difficulty is that teachers are lacking, and most of those who want to learn have to turn to books. That is why a new book on genetics is so important at the moment.

Dr. Edgar Altenburg, the author of the present work, comes from the famous *Drosophila* laboratory at Columbia. His book is intended for university students. It follows a plan now commonly adopted for such books in the United States. It omits references to original papers, devoting, on the other hand, as much as a third of its matter to summaries of each chapter and to statements of problems, or examination questions; both of these are accurately indexed—more so, indeed, than the text.

It might be objected that this method encourages the novice to acquire fixed and final ideas on each aspect of the subject before the matter is further developed. This objection does not, however, apply to the present case, for in fact matters are not further developed. In the general treatment ideas are not joined together. A work on anatomy or systematics would not perhaps be seriously impaired in its educational use by such incoherence. A work on genetics, however, is bound to suffer. That the author has never felt any difficulty of this kind is apparent from such a sentence as the following, from Chapter 1 (which he puts in italics as being of special moment), "We may then define heredity as the transmission of the germ plasm from parents to offspring"; and the germ plasm he has defined six lines earlier as "the hereditary material". Similarly, in the text of Chapter 2, he tells us that "The question 'Which is more important, heredity or environment?' raises a problem which really has no answer"; but in the summary of the same chapter the wisdom of this remark has been distilled into "Heredity and environment are equally important in the development of the individual". You pay your money and you take your choice. Again, in Chapter 11, the author devotes a great deal of trouble to explaining how crossing-over takes place between paired chromosomes at meiosis. But in Chapter 1 he has already described the two divisions of meiosis as reductional and equational, a terminology which has no meaning where crossing-over takes place. Genetics used to be like this thirty years ago. But need it be so to-day?

So much for modern aspects of the subject—and Altenburg claims to be really modern. Genetics, however, is less modern, as well as more modern, than he imagines. The theory of natural selection, an integral part of modern genetics, can be usefully connected with the work of Darwin. The chromosome theory of heredity can likewise be usefully connected with Weismann and the classical school of German cytologists. Yet the contributions of Weismann and Darwin are referred to only among "problems". There is no argument in the text which requires their introduction: Darwin is mentioned only as the author of the pangenes and the father of a large family.

In place of ancient history, Altenburg offers the most recent of his own ideas: "Some species seldom mutate, as judged by the fact that they have so few varieties. This, for example, is true of the goose. By contrast there are many varieties of chickens, due perhaps in part to a relatively higher (*sic*) mutation rate" (p. 347). Has a conclusion been reached? Probably not. But certainly it would be difficult to create more false impressions in three sentences. One wonders what the author would have made of Fisher and Haldane, Sewall Wright and Vavilov, if he had mentioned them.

Altenburg's book has one thing in common with genetics. It is founded on Morgan. It does not, however, integrate Morgan's ideas with the great achievements of those who came before him and of those who have come after him; on the contrary, it merely fills them out with such intellectual roughage as has been quoted. Such matter can be read, to be sure, without danger of expanding the mind of the student or the teacher, or of finding practical application. But it is not modern genetics.

C. D. DARLINGTON

PRACTICAL VERTEBRATE ANATOMY

Atlas of Outline Drawings for Vertebrate Anatomy

By Prof. Samuel Eddy, Prof. Clarence P. Oliver and Asst. Prof. John P. Turner. Pp. vii + 80. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1947.) 12*s*. net.

THIS is one of those books of outline drawings which are so popular in the United States. There is neither text nor indication of how the dissections should be carried out; but for each animal unlabelled diagrams are given of the important external and internal features, including the system of skeletal muscles. The main types dealt with in detail are *Amphioxus*, the dogfish, *Necturus*, and the cat.

From almost every point of view the book is unsuitable for use in Britain. Of the four main types, only *Amphioxus* and the dogfish can easily be obtained here, but an even more serious criticism is that of the use for which the book is designed. Its aim, as set out in the preface, is to save the student the necessity of "laborious drawing", and to meet the needs of those "with little drawing ability". All that remains to be done is to add labels to the diagrams provided. Such a method of undergraduate training cannot be too strongly condemned. Whether or not the student happens to be naturally clever with his pencil matters little. What does matter is that he should be forced by the act of attempting to draw to make close observation of the specimen before him. In no other way can he easily be trained to pay attention to detail, and in no other way can his attention to detail be checked. It is also not unimportant in the training of any zoologist that he should be given abundant practice in the craft of making clear drawings of his work. Whatever part he may ultimately play as a zoologist, he will have constant need of this ability.

For these various reasons this new atlas cannot be recommended.

W. S. BULLOUGH

Modern Paper-Making

By Robert Henderson Clapperton and William Henderson. Third edition. Pp. xii + 380. (Oxford: Basil Blackwell, 1947.) 30*s*. net.

THIS is the third edition of a book first published in 1929, when it at once established itself as a standard work on the practical aspects of paper-making. It owes this status to a somewhat rare combination of qualities, for not only does it contain valuable information, but also this information is imparted in a straightforward and understandable style. Since the authors are practical paper-makers of wide experience, it is understandable why their book has played such an important part in educating a younger generation of paper-mill workers.

It is with this in mind that a reviewer's comments must be judged. It may be argued that chemistry and physics should figure more prominently, especially in view of the increasing importance of the paper-mill laboratory. The answer is that the treatment is adequate, having in mind the requirements of readers of the above type. The opportunity of a third edition might also have been used to make some reference to the complete change in the raw materials situation since 1939, and in particular to the importance of straw and the wood pulp shortage, since the former has probably come to stay and the latter has reacted so strongly on the everyday life in Great Britain. On the other hand, the writers have confined themselves so strictly to practical paper-making matters in other respects that their decision that there has been insufficient change in general paper-making practice since 1941 to warrant rewriting the book must be accepted as wise in the circumstances.

The scope of the book covers fibrous raw materials for paper, boiling, bleaching and washing methods, beating and other beater operations, the paper machine (six excellent chapters, including one on newsprint manufacture), hand-made paper, finishing methods, paper testing, water supply and soda recovery. There are 157 clear illustrations, and the book concludes with an appendix of useful tabular matter, and an index.

It is a pleasure to be able to recommend this book unreservedly to all interested in the practical aspects of paper-making, and particularly to the student.

JULIUS GRANT

Lecture Experiments in Chemistry

Third edition, with Supplement. By G. Fowles. Pp. xvi+612. (London: G. Bell & Sons, Ltd., 1947.) 25*s*. net.

IN this, the third edition, some sixty experiments have been added as a supplement at the end of the book, and the bibliographies have been brought up to date. On the historical side, information which the author has found in "Chemical Pastime", by F. Accum, 1817, has led to the revision of the dates to a number of the experiments.

In Part 1 of the Supplement there are many valuable experiments, some of which deal with subject-matter not previously treated in the book, as, for example, osmotic pressure, indicators, soluble anhydrite as a drying agent, and the cleaning of mercury, while others are supplementary to those given in the previous edition. In this category all teachers of general chemistry will welcome the experiments on electrolysis with J. A. Mattuck's improved cell.

In Part 2 of the Supplement, experiments are described which will serve as an introduction to the effects of temperature, pressure and concentration on equilibria. In general this section is well done, but it is a pity that the experiments on the solubility of hydrogen chloride and sodium nitrite will not make it clear to the student that it is the heat change at the point of saturation which decides the effect of temperature on the solubility of a substance.

The previous editions of this book have received a very warm welcome and the reviewer is confident that this one will meet with a similar response; it is, indeed, a book which no teacher of general and inorganic chemistry can afford to be without. The publishers are to be congratulated on the good quality of the paper and binding.

A. C. C.

Peach Orchards in England

Being an Account of How to Grow Good Peaches in this Country. By Justin Brooke. Pp. 86 + 12 plates. (London: Faber and Faber, Ltd., 1947.) 7*s*. 6*d*. net.

MR. JUSTIN BROOKE is an enthusiast with a sense of proportion. He grows fruit commercially on a considerable scale near Newmarket, has grown and marketed peaches since 1936, and outlines, in the present volume, details for a great expansion of the crop in Great Britain. The variety Peregrine yields heavy crops and is self-fertile; it is best grafted upon the Broad Leaf Mussel stock. The author considers that peach blossom is rather less sensitive to damage by spring frosts than Victoria plum blossom. Manuring should be directed towards the production of vigorous growth, and pruning should also be subordinated to the same end. Thinning of fruit to one every four inches of branch is necessary, and the would-be grower will find adequate detail of all cultural aspects, and of pest and disease control, in the text and in the twelve excellent half-tone plates. Mr. Brooke points out that mechanized corn-growing and fruit production go well together, and it is greatly to be hoped that some of his readers will be stimulated to repeat his experiment in other parts of Britain. It would indeed be a national asset if peaches were within the economic reach of all members of the community.

Les plantes et la vie

Par Prof. Florian Cosandey. (Sciences et médecine, Série des Sciences naturelles.) Pp. 190+10 plates. (Lausanne: F. Rouge et Cie.; Paris: Masson et Cie., 1945.) 210 francs.

THIS book, as stated in the introduction, is written for readers used to university lectures, but who are not specializing in science. It is written by the professor of botany at the University of Lausanne. The material is well chosen and the style attractive. The fundamental physical and chemical features of plants are described and illustrated by diagrams which bring out these relationships with clearness. Such matters as vitamins and hormones are briefly introduced to the reader, and the importance of molecular films is discussed in relation to the surface activity of the vacuole and cytoplasm. The general metabolism of the plant is treated in outline and the characteristics of organic acids, albumins, proteins, glucosides and alkaloids described. A chapter follows dealing with cell structure. There is a preliminary chapter which gives an outline on physico-chemical conceptions which will aid the non-scientific reader to appreciate the following chapters.

It appears that this is only one of a series of similar books dealing with various aspects of science and medicine.

AN ESSAY IN CORRELATION ARISING FROM ALKALOID CHEMISTRY*

By Sir ROBERT ROBINSON, F.R.S.

THE incident which I wish to describe is of peculiar interest, because it transpires that the behaviour of a natural product can only be explained in the light of knowledge comparatively recently acquired and never previously brought to bear in the analysis of a structural problem.

When we break up molecules in order to examine the fragments, or submit them to transformations in order to recognize the reactive groups, the changes that occur usually follow relatively simple rules; the pieces, for example, are clearly related to the whole from which they were obtained. In certain classical instances the picture has been confused by rearrangements of atoms within the molecule in the course of some of the changes examined.

But these molecular shifts also follow laws which have gradually been brought to light, and it has always been possible to integrate the data in terms of a particular molecular structure.

Thus camphor showed itself to be a chemical proteus and at one stage it was not clear which manifestation corresponded to the reality. The vagaries of this molecule which proved most puzzling were explained by Lapworth. Camphor and all its derivatives have been synthesized and thus all dubiety was resolved.

Brazilin is another molecule which twists itself into contortions, and here again we can follow all the varied transformations, and we have the confirmation of synthesis, not, it is true, of brazilin itself, but of many of its more important derivatives.

But the star performers in the team of molecular acrobats are undoubtedly the alkaloids of the morphine group, and I shall speak especially of thebaine.

In 1923–25 I discussed the chemistry of morphine, codeine and thebaine with John Masson Gulland, whose untimely death in a recent railway accident was so great a tragedy. We arrived at a solution of the problem which has since been generally accepted, but there is no synthetic proof that applies to the thebaine structure itself. The certain knowledge from analysis and synthesis relates to the various transformation products, and the molecular structures of many of these are established beyond doubt. The validity of our formulæ, therefore, is estimated entirely on their success in interpretation of a complex of data. With an emendation in one group of products, suggested by Schöpf and gladly accepted, it seemed that the book was all but closed. Yet the most remarkable rearrangement of the molecule and one of the most extraordinary changes yet encountered in the whole domain of organic chemistry remained to be recognized. It subjected the Gulland–Robinson formula to a very severe test, and its triumphant emergence from the ordeal was at one time in doubt and has only been guaranteed during the last two months.

In 1905 Freund treated thebaine with phenylmagnesium bromide and obtained a new base, phenyldihydrothebaine, which was just thebaine to which the elements of benzene (C_6H_2, H) had been added. Similar substances were made later using other organo-metallic reagents, and Lyndon Small and his collaborators have carefully re-examined and extended the series. They have established some intriguing stereochemical relationships and corrected mistakes of other workers.

In 1943, in the course of a visit to Washington, I was privileged to hear of Dr. Small's results and to examine the detail of his brilliant experimental work. Two conclusions appeared to me then to be inescapable; but the full solution of the mystery remained elusive. In September of this year Dr. Small kindly sent me the manuscript of a paper intended for publication in the *Journal of Organic Chemistry*. He had been unable to make any use of my views, and further correspondence showed why that was so, and also led to the understanding that the present disclosure should be made. A new idea, based on the postulates of 1943, then occurred, and the validity of this has recently been indicated by a crucial experiment.

The first of the inescapable conclusions to which I have referred is derived from a comparison of thebaine with phenyldihydrothebaine. The latter is outstandingly more stable. It is hard to hydrogenate in the presence of a catalyst (thebaine is easily attacked), and when reduction does occur all that happens is a break of a C—N bond. Thebaine is very easily hydrolysed as an enol methyl ether; but although phenyldihydrothebaine contains this methoxy group (also one other OCH_3 and a phenolic OH), it is not hydrolysed by hot concentrated hydrochloric acid. But hot hydrobromic acid produces the change $(OCH_3)_2(OH) \rightarrow (OH)_2$, and the action of diazomethane on the trihydroxy-compound gives a trimethoxy-compound which is the methyl ether of phenyldihydrothebaine. From these facts it is perfectly clear that the near-aromatic nucleus of thebaine, which bears the hydrolysable methoxyl, has become truly aromatic in phenyldihydrothebaine.

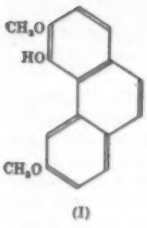
The second conclusion follows logically from the first, considered in the light of other data. Phenyldihydrothebaine is optically active and by Hofmann's exhaustive methylation procedure it gives a series of optically active derivatives; this is even true of the second stage in which nitrogen is eliminated. The process is C—C—N—C—C $\longrightarrow$ C=C⋮NMe$_2$⋮C=C. The two double bonds in this optically active product can easily be shown to be present by diagnostic tests.

Now phenyldihydrothebaine is a C_{25} base and one carbon atom is in $:NCH_3$ (now lost), two carbon atoms are in OCH_3 groups, and by hypothesis eighteen carbon atoms are in three benzene rings (two of the thebaine skeleton and the phenyl group introduced by the reagent); that leaves only four carbon atoms for the two double bonds. Hence exhaustively methylated phenyldihydrothebaine cannot contain an asymmetric carbon atom and it must owe its optical activity to an *asymmetric molecule* of the type familiar to synthetic chemists and stereochemists but never before encountered in the study of a natural product.

It is easy to guess what kind of an asymmetric molecule is present. Thebaine is easily degraded to phenanthrene derivatives (such as I) and these in their turn are derived from diphenyl (II).

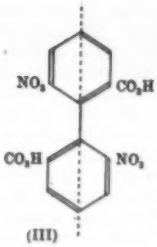
In 1922 Christie and Kenner showed that the dinitrodiphenic acid (III) could be resolved into optically active forms. They also pointed out that this result was explicable if the two rings are assumed to be co-axial (as shown by the dotted line) but not co-planar. In 1926 Turner and Le Fèvre, Bell and

* From the presidential address to the Royal Society, delivered on December 1.



(I)

(II)



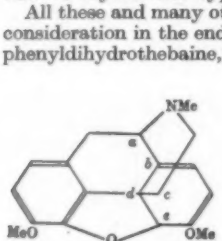
(III)

Kenyon, and Mills developed the hypothesis that restricted free rotation of the phenyl groups is conditioned by the position and size of the substituents. It is well known that this hindrance theory harmonizes all the extensive experimental data.

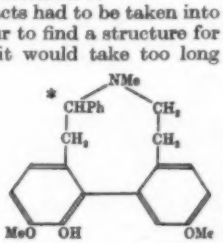
We arrived at the restricted diphenyl idea as a plausible explanation of the optical activity of the end-product of the Hofmann degradation; but there is strong evidence that it must also be applied to phenyldihydrothebaine itself.

Small and his collaborators have shown that Freund's phenyldihydrothebaine is a mixture of two isomerides (equated in various ways, as by reduction, or exhaustive methylation) which he calls (+) α and (+) δ. On heating, (+) α is partly changed to the optical antipode of (+) δ; similarly (+) δ goes partly into the optical antipode of (+) α. The equilibria, reached from either side, favour the α forms. Small clearly recognizes that these changes are partial racemizations but appears to think it possible that a number of asymmetric centres could be inverted in step. He calls the optical antipode of (+) α, (−) α; but it is preferable to term it (−) δ. Thus +, − and α, δ can be taken to be symbols representing left-hand or right-hand at each of two sources of dissymmetry. The partial racemization of (+) α gives then (−) α. These facts alone suggest that the phenyldihydrothebaine molecule contains two sources of dissymmetry and only two; one of these (represented by +, −) is a non-co-planar diphenyl configuration, and the other (represented by α, δ) is an asymmetric carbon atom. We are able to substantiate this view, and the substance is therefore the first in which molecular dissymmetry, and that due to an asymmetric carbon atom (also, strictly speaking, molecular), co-exist. The theory extends to this case without modification; there are the usual numbers of isomerides, 2^n, where n is the number of sources of dissymmetry, not necessarily all asymmetric carbon atoms. This principle is quite obvious but has not previously been enunciated, chiefly because the mixture of asymmetric types is itself new.

All these and many other facts had to be taken into consideration in the endeavour to find a structure for phenyldihydrothebaine, and it would take too long to carry the argument through all its stages. It will be stated more fully elsewhere; meanwhile phenyldihydrothebaine is believed to be (V) and its formation from thebaine (IV) is the result of molecular rearrangement of quite a new type.



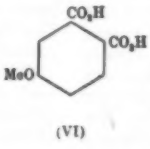
(IV)



(V)

It was first formulated as a likely process from the electronic point of view. In words: the migrating ethanamine chain is cationoid, (*c*) is joined to (*b*) by means of the electrons of the link (*a b*); the electrons in (*c d*) go to (*d e*) and fulfil the demands of aromaticity of the nucleus; electrons (*e f*) are then taken by the oxygen atom which acquires a negative charge (on decomposition of the complex by water, a proton is attached to oxygen); the phenyl anion brings a new electron pair to (*a*), replacing those lost to the migrating group (*c*). This connected series of changes can be thought of as starting at either end; namely, attack by Ph—, or assumption of a negative charge by oxygen. As in many other migrations in this group, the driving force is doubtless the tendency of the near-aromatic group to become fully aromatic. The formation of isomerides is due to construction of the —CHPh— group in each of the two possible senses, the diphenyl skeletons being configured in one sense only.

The formula (V) is perfectly satisfactory; examination of models shows that the nine-membered ring allows the phenyl nuclei to be disposed at right angles or at any intermediate angle without strain; there is one asymmetric carbon atom marked * in the formula (V); all the chemical properties and transformations receive natural explanations. But there was thought to be one important exception, and because of it Dr. Small was not disposed (some time before the complete theory was available) to accept the postulation of the two aromatic nuclei. The ultra-violet absorption of phenyldihydrothebaine gave no indication whatever of the appearance of a new aromatic ring in conjugation with the first. This ought to have been thought decisive, but as it conflicted with other equally definite evidence, something had to be jettisoned. Actually a further correlation is possible, and the parts now fit together like a Chinese puzzle made in ivory.



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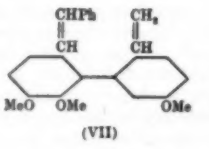

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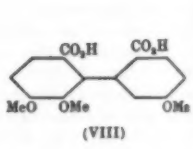


(VIII)

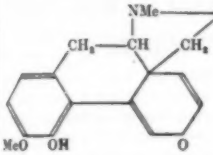
I am indebted to Dr. J. W. Cornforth for pointing out that non-co-planar diphenyls do *not* exhibit normal ultra-violet spectra. This was first noted by Picket, Walter and France (1936), and a clear case is given by O'Shaughnessy and Rodebush (1940). In this example a large ring of eighteen members is formed by a bridge across the *m*-positions of a diphenyl derivative. There is no diphenyl band and only end-absorption.

In the last few weeks we have sought and obtained experimental confirmation of the structure (V). Mr. K. W. Bentley has oxidized phenyldihydrothebaine with potassium permanganate and obtained benzoic acid, benzaldehyde, and 4-methoxyphthalic acid (VI). This was identified very thoroughly with an authentic specimen.

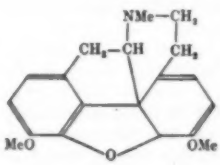
By exhaustive methylation, including that of the phenolic group, an optically active product (VII)

(made by Freund but stated to be optically inactive) was obtained, and oxidation of this by permanganate in acetone afforded a trimethoxydiphenic acid (VIII). These are very cold, hard facts, and it is to be feared that in the future they will be cited first and all our interesting arguments will be forgotten.

One further punctilio. The thebaine transformations are like the variations of a chess problem in that they have a common key-move. Are we justified in assuming that the problem as set has a unique relation to the variations? Is the thebaine structure proposed by Gulland and Robinson the only one which serves to explain the whole of the results? The key-move is the migration of the ethanamine chain from (*d*) to (*b*) in (IV); it is only the position *after* the migration that we have proved to be correct. Taking everything into consideration, one alternative can indeed be seen. This can best be explained by reference to the intermediate (IX) now postulated in the complex changes that thebaine undergoes in acid solution.



(IX)



(X)

(IX) arises from (IV) by migration from (*b*) to (*d*) and by hydrolysis. It could equally well arise from (X). The only way of distinguishing between (IV) and (X) seems to be by a study of the α- and β-methylmorphimethines; and the optical data on these substances strongly support (IV) and would remain inexplicable on the basis of (X). According to Dr. R. Strauss, the ultra-violet absorption of α-methylmorphimethine is not styrenoid and would be consistent with the arrangement, φ.C.C:C.C:C—. On the other hand, that of the β-isomeride shows strong conjugation consistent with φ.C:C.C:C.. The skeleton of (IV) permits these rearrangements and structural elements, but that of (X) does not. The question is related to that of biogenesis and further inquiries must be instituted.

THE INTERNATIONAL METEOROLOGICAL ORGANISATION

MEETINGS IN TORONTO AND WASHINGTON

THE meetings of the International Meteorological Organisation which were held in Toronto and Washington between the beginning of August and mid-October 1947 were of unusual interest, not only on account of the results achieved, but also on account of some of the precedents that were created. It was the first time in its seventy-five years history that any of the constituent bodies of the Organisation had met in the New World, and it was also the first occasion that all ten of the technical commissions had gathered together concurrently.

During the War, the activities of the Organisation were seriously curtailed, but as soon as possible after the return of peace, steps were taken to set its machinery in motion once again. An Extraordinary Conference of Directors took place in London during February 1946; new members of the International Meteorological Committee were elected and the technical and regional commissions were reconstituted. This Conference thus cleared the way for a resumption of the international procedures in operation before the War and for the world-wide introduction of improvements in the field of scientific meteorology made by certain countries during the War.

The objects of the meeting at Toronto and Washington were therefore to review and consolidate the progress made since the London conference, to make plans for the future and to consider the structure of the International Meteorological Organisation and its relationship to other international associations.

The meetings of the ten technical commissions in Toronto were spread over six weeks in August and September, and were attended by 179 delegates from forty-four countries. The scope of the proceedings was so wide and the discussions so detailed that even a summary of the activities of each commission would be too lengthy, and attention must therefore be restricted to an arbitrary selection of the main items.

The Aeronautical Commission, which was in session for three weeks, undertook the preparation of a common text for regulations to be adopted by both the International Meteorological Organisation and the International Civil Aviation Organisation for the provision of meteorological facilities to aviation. Codes for the transmission of weather reports to and from aircraft, and for the transmission of terminal and route forecasts between ground stations and to aircraft in flight, required lengthy discussion before agreement was obtained. The Commission for Maritime Meteorology dealt with such problems as marine climatology, the reporting of sea ice by ships, the measurement of ocean waves and swell, and means of increasing the frequency and accuracy of weather reports received from ships. The operation of ocean weather ships and their most suitable stations were also discussed.

The construction of a basic code for weather observations, with specifications for the various elements to be reported, was one of the chief tasks of the Commission for Synoptic Weather Information, and a code acceptable to all countries was eventually devised. Other subjects considered included methods of representing upper-air data on charts, the standard times of synoptic reports and the arrangements for the collection and distribution of meteorological information. The Commission for Instruments and Methods of Observation was formed at the London Conference in 1946, and met for the first time at Toronto, although in the intervening period much work had been done by correspondence. A comprehensive agenda had been prepared, and the Commission surveyed the whole field of meteorological instruments. The discussions usually turned on questions of standardization; but it was generally felt that only a limited degree of standardization should be the present objective, because much of the equipment in current use was relatively new and capable of further development. It was agreed, however, that comparison of different types of *radio-sonde* is necessary, and recommendations were made for the design of a simple reference instrument. Problems of visibility measurement were also dis-

cussed and changes in international practice recommended.

The work of the Aerological Commission has grown in importance owing to the increase in the volume of data relating to the free atmosphere. The regular meetings of the Commission considered, *inter alia*, definitions and specifications of water vapour in the atmosphere, values for certain physical constants in common use and the operation of meteorological reconnaissance flights; but additional sessions were arranged for lectures and discussions at which the trends of modern research were studied.

The increased attention which economic concerns are devoting to meteorology was reflected in the work of the Climatological Commission, which formed a permanent Sub-Commission to examine the applications of climatology to health and industry. The remaining Commissions—those for Hydrology, Agricultural Meteorology, Bibliography and Publications, and for the Projection of Charts—also held successful meetings and made valuable recommendations.

The technical commissions finished their work in Toronto on September 15, and a week later the Conference of Directors opened in Washington. The agenda contained, in addition to some four hundred resolutions submitted by the technical commissions, a proposal to form a World Meteorological Convention, and another to seek affiliation to the United Nations.

With regard to the Convention, the International Meteorological Organisation has hitherto been a semi-official association of Directors of Meteorological Services, but the increased importance of meteorology in a number of directions has led to a widespread belief that the Organisation should be replaced by an inter-governmental body which would be in a more favourable position to enlist official support. The proposal for a Convention gave rise to protracted discussion, and it was clear that some of the delegates were not without misgivings as to the wisdom of a change in the existing organisation. The subject was treated with the utmost frankness, and eventually, after proper safeguards to ensure the equality of meteorological services on technical matters had been provided, a World Meteorological Convention was drafted and signed by thirty-three countries. It will come into force on ratification by thirty countries, and the World Meteorological Organisation will take over the assets and obligations of the existing International Meteorological Organisation, which will cease to exist.

A decision to seek affiliation to the United Nations was quickly reached once the subject of the Convention had been settled. With the assistance of delegates from the United Nations who were present at the Conference, a draft agreement was drawn up which, after approval by a majority of members of the International Meteorological Organisation, will be submitted to the United Nations. If this is accepted, the World Meteorological Organisation will be linked with the United Nations as a specialized agency.

On the technical side, the Conference approved more than two hundred resolutions of the technical commissions, and formed two new commissions, one to study radio-electric meteorology and the other to deal with problems of Arctic and Antarctic meteorology. At two sessions, which were attended by delegates from the International Civil Aviation Organisation, measures designed to co-ordinate the activities of the two Organisations in meteorological affairs were agreed.

The Toronto and Washington meetings, considered either separately or as a whole, were most successful, and well repaid the sustained effort that was required from the delegates. Considerable progress was made both on the technical side and in improving the machinery for applying meteorology to human welfare. One of the most important results was, of course, the signing of the World Meteorological Convention. This decision to effect a fundamental change in the status of the International Meteorological Organisation illustrates the determination of members to adapt the Organisation to modern world conditions. Another promising feature was the emphasis placed upon research, and at the meetings of the technical commissions it was gratifying to notice that the delegates included a high proportion of younger men of science of great ability and originality of outlook.

THE TEAK FORESTS OF BURMA

By Prof. E. P. STEBBING
University of Edinburgh

THERE is probably more romance wrapped up in the history of the great teak forests of Burma, without the addition of the latest war chapter of the Fourteenth Army, than in any other afforested region of similar size in the world. To a large extent the teak tree is itself responsible. Our acquaintance with these forests, so far as the British personally are concerned, commenced with the inquiries into their resources made by the Government after the acquisition for political reasons of the Tenasserim and Martaban Provinces, ceded to the British by Burmese under the Treaty of Yandaboo early in the year 1826. Although the British in India and the Admiralty at home had obtained a certain amount of teak from Rangoon and Moulmein, the largest amount utilized up to this time came from the accessible parts of the teak forests in Malabar on the west coast of Madras. These, in the hands of timber exploiters, were to a great extent cut out by 1830.

Dr. Wallich, superintendent of the Botanic Gardens, Calcutta, was sent to the new Province to report on the botanical features of the forests, and also on their potential possibilities both commercially and for the provision of teak timber required for military purposes. There were great stores of teak in the forests, he said. He advised, in view of the destruction caused in the Malabar forests by unchecked exploitation, that Government should declare its ownership of all teak and that the forests should be managed by Government so as to ensure against their ruin. He added, "No forest exists which can, with propriety, be called inexhaustible—at least none that is liable to constant and extensive demands for timber". The advice was not adopted by the commissioner-in-charge of the new Province. A system of leases was instituted under which the lessee was allowed to take up a block of forest on one or other of the rivers and operate as he liked; the few rules issued were generally disregarded. Moulmein, from little more than a large village, soon became an important town, and within twenty years the whole of the population were immersed in the teak industry to the neglect of any attempt at an improved and extended area under agriculture. A score of years after the annexation,

the greater part of the accessible forests had been treated in a fashion similar to the Malabar ones.

The licence method had proved to be a difficult one to supervise and, in the late forties, the Deputy Governor suggested to the Court of Directors that long 99-year leases should be given out in order to interest the licensees in growing teak, a long-term project. Later he earnestly recommended the Court of Directors to give authority to sell the whole of the teak forest lands in tracts of convenient extent and to convey to the purchasers a complete title. The Court of Directors was mercifully too wide-visioned to adopt this suggestion.

The Second Burmese War took place in 1852, the outcome being the annexation of the Province of Pegu on December 20, 1852. Rangoon was the capital, having been founded by the Alompra dynasty in 1775. It had been the principal mart for the export of teak timber for nearly a century, teak being the chief staple industry of the port at that time. The teak tree had been proclaimed a royal tree by this dynasty, and was a royal monopoly, as had been the case with Tippoo Sahib in Southern India, and in the neighbouring Travancore and Cochin States. Following this precedent, soon after the annexation a notification was issued by the Governor-General that all the forests were the property of Government and no general permission to cut timber therein would be granted to anyone. But differences of opinion soon arose between the commissioner appointed to administer the Province and the forest officer. The Governor-General had proclaimed the teak public property, but both the above officials agreed that the Tenasserim royalty of 15 per cent only should be levied on all timber brought down river to Rangoon. The differences between them were on other issues. This led to the famous minute from the Governor-General, Lord Dalhousie, which has been termed "The Charter of the India and Burma Forests". In this he directed attention to his former notification on the ownership of teak, which laid down that the teak timber should be retained as State property. In effect, Lord Dalhousie laid down that the forests were the property of the State, which meant of the public, and that the material in them should be sold at a price the market was prepared to pay—that the system by which the timber merchant made the greatest profit must cease. In the past, big timber firms had been in the habit of getting a permit to take up blocks of teak forest and work them out for teak, paying the Crown a lump sum down and an agreed price per tree or log extracted. The profits, as in the case in Moulmein, of the timber speculators had been excessive, while the activities of the whole people were confined to one business, to the detriment of agriculture.

Lord Dalhousie found a man in Dr. (later Sir Dietrich) Brandis to give effect to his proclaimed policy. Brandis was appointed superintendent of the Pegu Forests in January, 1856, and shortly after to those of Tenasserim. The first step was to put an end to indiscriminate felling in the forests by obtaining some figure of their volume-value in teak, to enable him to prescribe the volume per unit of area which could be safely cut without overfelling in the forest. He instituted his now well-known 'strip surveys'—marching through the forests on a line previously laid down and measuring up on either side all teak trees on a 50 ft. strip. He made four girth classes: 6 ft. and more; 4 ft. 6 in. to 6 ft.; 3 ft. to 4 ft. 6 in.; less than 3 ft. An area of 30 square miles was covered by these linear surveys, on which 2,423 trees of 6 ft. and more had been counted, or an average of eighty trees per square mile. It was estimated that the teak in Pegu was scattered over an area of 7,000 square miles, giving a grand total of 385,000 first-class trees of 6 ft. and more. On this he based the number of trees he could mark for sale each year. The danger of ignorant over-felling was past. The teak had to be girdled when marked and stand in the forests for two to three years to dry; since green teak will not float, and much of the teak was transported from the forest to the market at Rangoon by floating down the rivers. Later calculations of the volumes of teak in the forests made by a more numerous staff proved that Brandis' figures were extraordinarily accurate, considering the rough methods he had to use.

Brandis considered that Government must show the way and prove that the forests could be worked efficiently, the trees felled and logs extracted with the minimum of damage, while, at the same time, the prices received for the timber would repay all charges of felling and extraction and show a handsome surplus. Brandis started work, hiring contractors to fell the timber, drag it to the floating streams and raft it to the sale depots. Local contractors and others more powerful at a distance put every obstacle in the way of the new departure, and it took a man of Brandis' forceful nature to fight and live down this concentrated opposition. The Government was by no means convinced as to the soundness of Brandis' proposition. In its view the first necessity was to ensure that the annual amount of teak timber required by the Government services was forthcoming without any danger of deficiencies: the second that in the first few years working the costs were larger than the receipts. The powerful timber contractors carried the matter to the Privy Council; but the Government's view was upheld in its main contention—that the teak forests were public ownership and should not be worked unchecked by timber exploiters. Brandis soon saw that it would be impossible to work such large areas departmentally, owing to the want of staff and other reasons. He therefore suggested that 12–15 year leases should be granted to approved timber contractors for a definite forest area, the trees to be removed to be marked and girdled by the Forest Department, and the lease be subject to certain definite conditions as regards methods of felling, extraction, etc. This practice is still in force. The other directions in which a true forest administration was commenced in Burma are by now well known. In 1861 Brandis was transferred to India and appointed first inspector-general of forests to the Government of India, and in 1864 the Indian (including Burma) Forest Service was formed, to be officered by men trained in Europe.

The Third Burma War and the annexation of Upper Burma might be said to have witnessed the third advance in forestry progress in Burma. The political reasons are not under consideration. The proclamation of the annexation of Upper Burma in January 1886 was made just sixty years after the annexation of Tenasserim. The new territory placed an enormous area of potential teak and other forests under the Forest Department, the staff of which was far too small to deal with the task. However, progress was made in a remarkably short time by transferring some officers from India.

Once again, and for the last time, the big timber contractors sought to get a free hand in the exploitation of the teak forests in this new Province. Once again the fight was carried to the Privy Council.

But the Inspector-General of the day, Ribbentrop, who had had long experience in Burma as a forest officer, won his case: and all the more easily since it was possible to point to the Pegu Forests thirty years after Brandis had stopped unchecked fellings, and compare them with the position of the cut-out Malabar Forests in 1830 and Tenasserim in 1845.

The reservation of the forests went steadily forward during the last thirty years of the century. Another matter, first enunciated by Brandis, but not actually put into practice by him, was to make use of the nomadic shifting cultivation habits of the Shans and Karens by getting them to sow teak seed or plant in teak plants with their (shifting) cultivation. The idea was not new: both in France and Germany the practice had been in force in the past. In Burma the term 'taungya' had been given to the method, from the Burmese word for shifting cultivation. Considerable patches of young teak poles existed at the end of the century about the country, but as no record or map had been kept they had mostly been lost to sight in the encompassing forest. In the early years of the present century the method fell into abeyance, but was revived at Tharrawaddy during the second decade of the century with very great success. This practice was adopted in the case of *sal* in Bengal and spread throughout India and out to Africa and other parts of the Empire. I saw it in practice by the French forest officers in the Ivory Coast in 1934, copied from the work of British officers in Nigeria.

Forest administration based on sound sylvicultural management and finance made great progress in Burma during the first two decades of the present century. The First World War proved the soundness of the foundations laid. Great demands were made upon Burma to supply the requirements in Mesopotamia, and several other species besides the now commonly used ones, teak and pyinkado, were utilized, some remaining on the market afterwards.

Since the first successful attempt at protecting an Indian teak forest from fire (in the Central Provinces) during the hot-weather season in India had passed successfully, a fire protection system had been devised for all the reserved forests in India and Burma. Fires occurred annually; but the wholesale scale of former times had come to an end. At the beginning of the present century fire protection in the moist teak forests in Burma was called in question. It was found that a low growth of evergreen shrubs covered the forest floor, through which no teak seedling could penetrate. Careful examination showed this to be true in both the moist teak and moist *sal* areas (in India). Fire protection was, therefore, given up save in the very young new woods. As an outcome, a practice termed 'early burning' was adopted, with good results.

To the trained and experienced forest officer, the test of the efficiency, thoroughness and permanency of a forest administration can be studied in one way and one way only—by the presence of working plans in the area of forest administered, the degree of intensity on which the working plans are drawn, and the manner in which they are worked. A forest under a well-drafted working plan, which has passed the scrutiny of the higher forest authority, and been sanctioned by the civil administration of the country, is as safe as man can make it. Such plans laying down the whole management of the forest are usually drawn up for ten-year periods. Burma holds a high place in this important practice of the correct administration of a forest. It is understood that no serious damage to the teak forests was done during the Second World War. Teak is chiefly a timber felled for export. During the War, all teak exports ceased and the Japanese did not undertake any serious fellings in the teak areas, only cutting what they required for their military forces. In 1939 it may be said that Burma could show as fine a series of working plans for great forests from, to quote examples, the plans for South Toungoo and Tavoy in Tenasserim, South Pegu, Zigon and the Northern Shan States, to the Mu and Katha Forests and those of the Chindwin in the north. The work is not finished. For example, some of these working plans have been revised or re-written several times since the early days of the first real working plan (omitting the 'paper' or purely volume statistic plans of Brandis' day) of the early 'eighties. Others are first plans, as, for example, the Mu working plan drawn up for the period 1929–30 to 1938–39.

The total area of the Government reserved forests in Burma in 1938–39 on March 31, 1939, was 20,100,221 acres. The total volume of teak timber felled during 1938–39 was 1,402,548 cubic feet. The total volume of teak timber exported in 1938–39 was as follows in cubic tons: teakwood, 203,596; teak sleepers, 609; teak squares, 59,385; teak conversions, 137,401; teak round logs, 6,209; total, 407,200 cubic tons; teak keys (in tons), 4,753.

That long role of British forest officers which commenced with Brandis more than ninety years ago is now to terminate. They have done a magnificent work for Burma, and have left a great heritage to the Burmans. The latter are now going to take full control of this finely tempered forest administration and these enormously valuable forest estates. In bidding a farewell we can but wish them all success, coupled with the warning that there is no other property in the world which can be so insidiously depreciated, since it inevitably takes a term of years before the effects are perceivable or can be appreciated.

OBITUARIES

Dr. Cyril Strickland

Dr. Cyril Strickland, who died on November 3 in Jersey, aged sixty-six, was born in Cape Colony. He was educated at St. Andrew's College, Grahamstown, and at Oundle School.

After graduating with first-class honours from Caius College, Cambridge, he went to St. Bartholomew's Hospital, London, but before completing his medical course he accepted an invitation to study protozoology at Cambridge under Prof. G. H. F. Nuttall, whose assistant he became. During his tenure of this appointment he found time to take his degree in medicine. He also made the interesting and important discovery that the trypanosome of the rat was normally transmitted from rat to rat through the alimentary route by the mastication of infected fleas and not by the bites of the fleas as had previously been assumed.

In 1912 he went to Malaya to work on the malaria problem on behalf of the Government of the Federated Malay States.

Dr. (now Sir) Malcolm Watson had already been conspicuously successful in controlling by drainage the malaria of the flat coastland of Malaya; but the disease in the upland jungle remained a baffling problem. Strickland has described how, in the

course of his work, he found that the jungle in Malaya remained free from malaria until clearing operations produced suitable conditions for the breeding of the vector mosquitoes. This discovery was published in a Government Paper in 1915; its importance was at once recognized, as was shown by the issue of an official prohibition of the clearing of jungle over collections of water without special permission. In India it was hailed as a "brilliant discovery".

In 1922 Strickland became the first professor of medical entomology at the recently established Calcutta School of Tropical Medicine and Hygiene, and during his seventeen years tenure of this post he was able to give a practical demonstration of the value of his discovery by enlisting the enthusiastic co-operation of the medical men, managers and agents of the tea gardens of Assam and north Bengal. The remarkable improvement in the health of the workers in these gardens is believed to have been due for the most part to the policy of maintaining a dense leafy shade over all waterways.

A problem closely studied by Strickland during his long period of fruitful work in teaching and research at Calcutta was the influence of land structure on malaria; he made a special study of the deltas of the Ganges and Brahmaputra and in 1939 published his "Deltaic Formation" (Longmans, Green and Co.). He hoped eventually to correlate the vast amount of data that he had collected regarding the incidence of malaria in eastern India with his survey of land formation, but he was unable to complete this study because of being compelled to retire in 1939 by the superannuation rules of Government. He was then employed by the Army in organising malaria work in Burma, where the campaign was already foreseen. He finally retired from active work in 1942.

We regret to announce the following deaths:

Dr. Nicholas Murray Butler, for more than forty years president of Columbia University, aged eighty-five.

Mr. S. A. Courtauld, who built and endowed the Courtauld Institute of Biochemistry, and also endowed the professorship of anatomy at the Middlesex Hospital, on December 1.

Sir John Fraser, K.C.V.O., principal of the University of Edinburgh since 1944, on December 1, aged sixty-two.

Prof. Paul Monroe, professor emeritus of education in Teachers College, Columbia University, on December 6, aged seventy-nine.

NEWS and VIEWS

Presentation of Physical Society's Awards:

Charles Chree Medal and Prize

At the science meeting of the Physical Society at the Science Museum on December 19, the Charles Chree Medal and Prize for 1947 will be presented to Sir Edward Appleton, who will then deliver an address entitled "Geomagnetism and the Ionosphere". Sir Edward has earned an international reputation for his work on the characteristics of the ionosphere, for which he was recently awarded the Nobel Prize for Physics for 1947 (see *Nature*, November 22, p. 703).

Charles Vernon Boys Prize

At the same meeting the Charles Vernon Boys Prize for 1947 of the Physical Society will be awarded to Dr. C. F. Powell, reader in physics in the University of Bristol, for his development of the photographic-plate technique for the investigation of fundamental particles. Dr. Powell, who was born in 1903, carried out his first piece of research under C. T. R. Wilson at Cambridge on supersaturation in steam. In 1928 he became research assistant to Prof. A. M. Tyndall in the H. H. Wills Laboratory at Bristol, and in 1931 was appointed lecturer in physics there. His outstanding ability as an experimenter became evident in his systematic work on positive-ion emission in pure gases. Until a few years ago the Wilson cloud-chamber method was the only one used in the study of the tracks of high-speed particles, particularly if their energies were to be estimated. It occurred to Powell (and to others working independently of him) that it should be possible to make direct use of the photographic emulsion, in which the fundamental particles would have short ranges and the lengths and directions of the tracks could be measured after development of the plate. He originally used the method in the study of the processes occurring in cosmic rays. In 1938, with the aid of a Cockcroft 700-kV. generator which he had constructed at Bristol, he showed that quantitative information on nuclear processes could be obtained by this method. Since then, with the improved fine-grain emulsions produced by Ilford, Ltd., and with other facilities, he has established this technique as one of the most powerful instruments in nuclear study. It was by this technique that investigators in Joliot-Curie's laboratory discovered triple and quadruple fission in uranium nuclei. Powell himself has obtained range-energy curves for protons and other particles, and the recent discovery of new types of meson by Powell, Occhialini and Lattes has aroused world-wide interest. The presentation of the Charles Vernon Boys Prize will be followed by a brief address by Dr. Powell on the work which forms the basis of the award.

Centenary of the Exhibition of 1851

Mr. Herbert Morrison, Lord President of the Council, announced in the House of Commons on December 5 that the centenary of the Great Exhibition of 1851 is to be marked by a comprehensive national display in addition to the annual British Industries Fair. It is proposed that the year 1951 should be marked by comprehensive and co-ordinated displays demonstrating British contributions to civilization, in the arts, in science and technology and in industrial design. The Central Office of Information, acting on behalf of the various research councils and other scientific bodies, is to be responsible for the presentation of science and technology. The Council of Industrial Design will take charge of an exhibition of consumer goods, civil transport, some handicraft production and displays showing the historical development of certain

industries in Britain. The Arts Council of Great Britain is being asked to arrange, in association with other bodies, a Festival of the Arts, to include events in music and drama, opera and ballet, with exhibitions of painting, sculpture and photography. Arrangements will also be made to cover architecture, town-planning, books and films. No new building will, of course, be possible to accommodate the proposed displays and celebrations. Mr. Morrison emphasized that existing organisations would be invited to collaborate, and also that the provinces as well as London will be able to take a full part in the events, which will be spread over several months of 1951.

"Atomic Physics"

To attempt an intelligible outline of atomic physics on a film which takes about 1½ hours to show is no mean task; this, however, is what G.-B. Instructional Ltd. have done in the film "Atomic Physics", and it can be said at once that it is done very well. Prof. G. I. Finch, of the Imperial College of Science and Technology, London, gave guidance during the early stages of production, and the advice of Dr. J. D. Cockcroft, Prof. R. E. Peierls and Prof. O. Frisch was obtained. Prof. A. Einstein, Dr. Cockcroft and Prof. Frisch recorded interviews which appear at appropriate places in the film. In addition, the producers were given facilities to use historical apparatus and to photograph modern research equipment to illustrate the development of the theme; among those contributing in this way are mentioned the Royal Society, Royal Institution, Science Museum, Cavendish Laboratory, Imperial College, Research Laboratories of the G.E.C. (England), Messrs. Kodak and Cinema Television. Extracts of films of J. J. Thomson speaking on the electron, and of Lord Rutherford speaking on atomic structure, are included. The Atomic Scientists' Association arranged for one of its members to give technical guidance throughout the film.

The film is arranged in five parts, which can be shown separately. Part 1 is entitled "The Atomic Theory" and illustrates the developments of the nineteenth century, touching on Dalton's work, Faraday on electrolysis, and Mendeléeff's periodic table, and illustrating the current views on molecules and atoms. Part 2 is concerned with "Rays from Atoms" and deals mainly with J. J. Thomson's work. Part 3, on "Nuclear Structure of the Atom", reconstructs the work of Becquerel and the Curies, and is dominated by Rutherford. Part 4, on "Atom Smashing", carries the story up to the work of Cockcroft and Walton, giving also an account of Sir James Chadwick's discovery of the neutron; modern research equipment is illustrated in this part of the film. Part 5, "Uranium Fission", requires little explanation; the atom bomb is dealt with and an idea given of some of the present aims of peace-time research on atomic fission, with a solemn warning of the dangers to mankind if international control of atomic energy is not achieved. Throughout the film, skilful use is made of animated diagrams to demonstrate the mode of action of experimental equipment; this is done by superimposing diagrams upon, and displacing, photographs of the apparatus. The theoretical discussions are also shown diagrammatically. The commentary is brief and to the point; with the recorded interviews, it completes a very able historical survey of the basis, present position and significance of atomic physics.

International Collection of Pure Chemical Substances

At the request of the United Nations Educational, Scientific and Cultural Organisation, and by agreement with the International Union of Chemistry, the International Bureau of Physico-Chemical Standards of Brussels has accepted the task of establishing a collection of pure chemical substances of every kind (metals, alloys, mineral and organic substances, plastics, samples of biological interest, etc.), to place them at the disposal of the laboratories and research workers of all countries, so as to enable them to control the nature and the purity of their own samples, or for any other research work. The expenses of the scheme, including distribution of the samples, will be met by a subsidy from U.N.E.S.C.O. An appeal is therefore being made to all laboratories and research chemists who have prepared, or have at their disposal, such substances in a state of sufficient purity, to send a sample to the new centre with a concise note showing its method of preparation and purification, and its principal constants. If a sample cannot be provided, a description with its constants might be sent, so as to enable the Bureau to establish a register of such substances. It is emphasized that this scheme is not intended to compete in any way with chemical industry, and that products easily obtainable on the market fall outside its scope. Research laboratories of the chemical industries, which often possess samples of rare substances, prepared for their own use in small quantities, and not included in the catalogues of industrial and commercial firms, are invited to co-operate. No samples should be sent without communicating first with the Bureau. Detailed information about the scheme can be obtained from the director of the International Bureau of Physico-Chemical Standards, Prof. J. Timmermans, Université Libre de Bruxelles, 50 Avenue Franklin Roosevelt, Bruxelles, Belgium.

Southwest Research Institute of San Antonio, Texas

The Southwest Research Institute, a non-profit scientific organisation for technological research in support of industry in the south-western United States, was opened in September. Mr. Tom Slick, who is closely connected with oil development and ranching in San Antonio, has given an endowment of more than 1,000,000 dollars. The Institute follows the pattern of the Midwest, Armour and Mellon Institutes in that it will conduct industrial research on a fee basis; under its charter, sponsoring manufacturers or trade associations retain patent rights on all discoveries accruing from research projects. The dedication ceremonies, at which Mr. Slick was present, took place in the historic old Cable Ranch House, when speakers pointed out that the Southwest Research Institute would provide facilities to the rapidly expanding industrial interests of the south-western States similar to those enjoyed by industry in the north and east. The Institute is the first of a series; the next is to be built in Houston and devoted entirely to petroleum technology; an office in the Oil and Gas Building has already been staffed to provide consultation services for manufacturers and processors in the area. The present staff of the Southwest Research Institute includes W. M. Hammond, acting director and business manager, formerly business manager for the Armour Foundation; Dr. H. C. Dyme, chemist and bacterio-

logist; Dr. John B. Loefer, biologist and authority on micro-organisms; Robinson Brown, mechanical engineer and oil equipment expert; Dr. Judson Swearingen, chemical engineer and authority on high-pressure processing, blowers and turbines; Dr. Paul A. Keesee, veterinarian known for his work in artificial insemination; Dr. F. W. Bieberdorf, botanist and authority on plant pathology; Mr. I. O. Gilbert, specialist in electronics and machine design.

The first laboratory of the Southwest Research Institute, functionally designed and equipped with modern instruments and machines, houses chemical and biological laboratories, engineering department, a complete machine shop with foundry, forge, tin shop, welding and heat-treating equipment, an animal room as part of the biological section, and various cold rooms, sustained humidity rooms, a self-contained power plant, distillation plant, and other scientific facilities. A separate, underground vault for storage of volatile chemicals is located near by. The Institute is the third and largest unit affiliated with the Foundation of Applied Research, an earlier organisation established by Mr. Slick and other trustees. The first unit of the Foundation is Essar Ranch, widely known for its pure-bred Hereford and Aberdeen-Angus cattle, its experimental cross-breeding of Angus and Brahman strains to produce a hardy beef cattle for tropical regions, and artificial insemination experiments. The second is the Institute of Inventive Research, which provides inventors with a complete processing service without cost.

Coconut Conference

Because of the present world shortage of vegetable oils and fats, and the fact that the situation is one which will take years to remedy, particular interest is attached to the oil-producing crops, their cultivation, conservation, potentialities and use. During the summer the Coconut Conference (Colombo, July 4, 1947) covered much useful ground, papers, chiefly of a directly practical nature, being devoted to the regeneration of plantations, the use of manures, the value of combining animal husbandry with coconut cultivation, problems of soil conservation, the control of insect pests, and problems of co-operation and marketing of coconut products. This report will undoubtedly prove of interest and value to scientific workers and members of the planting community in other tropical regions where the coconut is an important crop.

Marriage Hygiene

Marriage Hygiene, a quarterly journal published before the War, has been revived. The second series commenced with the issue of August 1947. The managing editor, Dr. A. P. Pillay, is an Indian. He is supported by a staff of editors representing Australia, Britain, China, Europe, the Far East, the Middle East, South Africa, South America, and the United States. It is therefore an international production. The British editor is Dr. Norman Haire, and the distribution in Britain is in the hands of H. K. Lewis and Co., Ltd., 136 Gower Street, London, W.C.1. The annual subscription is 22*s*. The August issue comprises sixty-four pages of articles, notes and comments, reviews and the like. An examination of this material shows that it is a journal of sexology rather than of marriage. Some of the subjects discussed are frigidity, sterility tests, incest, male sexual disorders, transvestism, and necrology. Such a journal, treating sexual phenomena with scientific detachment and in uninhibited detail, should serve a useful purpose in providing a forum for free discussion and the interchange of clinical data. It is to be hoped, however, that the title will be changed to place the emphasis where it properly belongs—upon sex rather than marriage.

Cosmic Rays and Cancer

Sky and Telescope of July has an article with this title, which describes the experiments of Dr. Frank H. J. Figge, of the University of Maryland Medical School, on mice. Male mice were injected with the cancer-inducing substance, methylcholanthrene, and were then distributed in eight cages, five of which were covered with quarter-inch plates of lead. When cosmic rays pass through thin sheets of lead, showers are produced, thus intensifying the effects of cosmic radiation; and the cages were so arranged that various groups of mice were differently exposed to the scattered cosmic radiation during the five months of experimentation. Those so exposed developed tumours in an average period of 8·5 weeks, while 11 weeks were required for those exposed to normal cosmic rays. Other experiments showed the greater susceptibility of mice exposed to cosmic-ray showers. It is true that direct radiation is less effective than secondary showers; but its effect over a life-time seems to be cumulative. Perhaps architects of the future may be called upon to assist in arresting the development of cancer by choosing building materials which will minimize the effect of cosmic-ray showers.

Library of the History of Medicine, Yale

The report for the year 1946–47 of the Historical Library of Yale University School of Medicine records the safe receipt, with only one damaged volume, of the Klebs Library from Geneva, where it was packed and stored in 1943 by the deputy librarian of the United Nations Library. The report also records the circumstances in which Dr. Henry Sigerist resigned in 1947 the chair of the History of Medicine in Johns Hopkins University, a chair which he had held for fifteen years, in order to devote himself to his eight-volume history of medicine. This great act of devotion to scholarship has been facilitated by the appointment of Dr. Sigerist as a professorial research associate of Yale University, with affiliation to the Historical Library of the School of Medicine. This appointment will enable him to continue his historical work at Pura, near Lugano. The first volume of his history of medicine is now nearing completion and will be published by the Oxford University Press.

Fitzwilliam Museum, Cambridge

The annual report of the Fitzwilliam Museum, Cambridge, for the year ending December 31, 1946, has been issued. It is the last report with which Mr. Louis Clarke, to whom the Museum is so much indebted, is concerned. His successor, Mr. Carl Winter, formerly deputy-keeper of the Department of Paintings in the Victoria and Albert Museum, London, is now in charge. The report follows the usual lines, and a number of important gifts and acquisitions have been received. Outstanding is Mr. Raphael's great, green jade recumbent buffalo (Han dynasty), which weighs no less than 56 lb. But there are also many other valuable additions to the collections in all the various departments.

Acta Hydrobiologica et Protistologica

A NEW international review on hydrobiology and protistology is to appear shortly, under the above title. The board of editors comprises Dr. G. Alm (Sweden), Prof. H. d'Ancona (Italy), Prof. K. Berg (Denmark), Prof. F. E. Fritsch (Great Britain), Prof. K. Münster Ström (Norway), Prof. William R. Taylor (United States), Mrs. N. Wibaut-Isebree Moens (Holland), Prof. P. van Oye (Belgium), managing secretary. Some seventy leading scientific workers from most countries of the world have promised to support the new periodical, which is intended not only for the publication of original papers on all branches of hydrobiology and protistology, but also for reviews of books and papers, information on scientific institutes, along with a personal section, correspondence, etc. The review is to appear in four quarterly issues of about 100 pages each; the price of each volume of four issues will be 40 guilders. Subscriptions should be sent to A. Oosthoek's Uitgevers Mij, Domstraat 1–3, Utrecht, Holland.

Britain in 1955

"BRITAIN IN 1955" is the theme of a special issue of *Future*, skilfully and collectively produced by a group of experts. The 'high light' is an economic analysis, from the vantage point of 1955, of the preceding decade; but other articles, particularly on the agricultural revolution, industrial relations, the universities, and meteorology, are also most stimulating. In effect, the future is foreshadowed by an informed examination, on specified assumptions, of current trends. A synoptic approach is adopted throughout. There are touches of "The Shape of Things to Come", "Erewhon", and "Brave New World" in judicious combination. An unreal element is the apparent disappearance of serious political controversy. Is this wishful thinking?

U.S. National Research Council Fellowships

THE U.S. National Research Council is again offering a number of fellowships for advanced study and research in the natural sciences. The post-doctoral fellowship programme, administered by the Council for the past twenty-eight years and financed by grants from the Rockefeller Foundation, is designed to permit young men and women who have demonstrated their ability in research in the natural sciences to spend additional time in uninterrupted study. Stipends are at the rate of 2,500 dollars a year, plus travel to the place of study. Since the War, Merck and Co. has supported a fellowship programme in the chemical and biological sciences, designed to stimulate interest in fields of study requiring knowledge of more than one science. These fellowships are therefore designed to give special training to young men and women who have demonstrated marked ability in research in chemical or biological science and who wish to broaden their fields of investigational activity. The annual stipends are in the range 2,500–5,000 dollars, with an allowance of 500 dollars a year to the institution to which each fellow is assigned. A third programme recently inaugurated by the Radio Corporation of America is designed to give special training and experience to young men and women who have demonstrated marked ability in the general field of electronics. Their preliminary experience may have been either in the fields of electrical engineering or physics. Applicants need not have completed more than one year of graduate work, and they must be United States citizens. The fields of study to be undertaken are in the sciences underlying the general science of electronics. Stipends range from 1,600 to 2,100 dollars a year. Further particulars of all these fellowships can be obtained from the National Research Council Fellowship Office, National Research Council, 2101 Constitution Avenue, N.W., Washington 25, D.C.

University of London: Appointments

THE following appointments in the University of London have been announced: Mr. W. D. Hogarth to be clerk of the University Court as from January 1 in succession to Dr. D. W. Logan, who becomes principal of the University on that date; Dr. L. P. Mair to the University readership in Colonial administration tenable at the London School of Economics and Political Science as from October 1, 1947; Dr. N. F. Maclagan to the University chair of chemical pathology tenable at Westminster Hospital Medical School as from October 1, 1947.

The degree of doctor of science has been conferred on Conrad Ellenby, of University College, and on G. M. Dyson, an external student.

The Botanical Society of the British Isles

THE name of the Botanical Society and Exchange Club of the British Isles has been changed to the Botanical Society of the British Isles. New and extended facilities are being offered to members, including the privilege of consulting a panel of specialists. A Conference on "The Study of Critical British Groups" is being arranged in London during April 9–10, 1948. All inquiries should be addressed to the honorary general secretary, Miss M. S. Campbell, c/o Department of Botany, British Museum (Natural History), Cromwell Road, London, S.W.7.

Commonwealth Agricultural Bureaux

THE Executive Council of the Imperial Agricultural Bureaux has decided to change the name of the Bureaux as from January 1 to Commonwealth Agricultural Bureaux. The Bureaux will continue as hitherto in control of the Institute of Entomology, the Mycological Institute, the Bureaux of Soil Science, Animal Health, Animal Nutrition, Plant Breeding and Genetics, Pastures and Field Crops, Horticulture and Plantation Crops, Animal Breeding and Genetics, Agricultural Parasitology (Helminthology), Forestry, Dairy Science, Biological Control and the South American Potato Collection.

Announcements

THE Medical Research Council has recently reconstituted the Dental Research Committee, the function of which is to advise and assist them in the promotion of scientific investigations in this field. The secretary of the Committee is Prof. M. A. Rushton, Department of Dental Medicine, Guy's Hospital, London, S.E.1.

A SERIES of three Christmas Lectures for Boys, on "High-Speed Flying and the Airport", has been arranged by the Institution of Civil Engineers. They will be given by Group Captain E. M. Donaldson, C. E. Foster, and Air Marshal Sir John D'Albiac, on December 30, January 2 and 6, at 3 p.m. Tickets, which are free, can be obtained from the Secretary, Institution of Civil Engineers, Great George Street, Westminster, London, S.W.1.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Chlorocruorin and Hæmoglobin

THERE are four respiratory pigments which circulate in the blood or are found in the body cavity of animals. Two of these, the red hæmoglobin and the dichroic red-green chlorocruorin, are close chemical relatives. Chlorocruorin is confined to certain marine polychæte worms and is characteristic of the group Serpulimorpha, comprising the families Serpulidæ and Sabellidæ. Hitherto it has been thought that all species in this group possess chlorocruorin in their blood. This, however, is not the case. I have found chlorocruorin in twenty-one species of the group, belonging to fifteen genera. One of the species with chlorocruorin is *Spirorbis borealis* Daudin, but another species of the same genus, namely, *S. corrugatus* (Montagu), has hæmoglobin as its blood pigment. Yet another species, *S. militaris* (Claparède), has neither pigment: its blood is colourless. That chlorocruorin and hæmoglobin are really absent here, not just dilute, is proved by the fact discovered by my colleague, Miss Jean Hanson, that the benzidine reaction is negative in the blood vessels of *S. militaris*. These several species of *Spirorbis* live in similar situations, so that the possession of either or neither respiratory pigment appears to be functionally unimportant.

In *Serpula* the blood contains both chlorocruorin and hæmoglobin. It is greenish-brown in colour and has three strong absorption bands in the visible region of the spectrum, namely, the α-band of oxychlorocruorin and the α- and β-bands of oxyhæmoglobin. MacMunn[1] saw this spectrum, but did not recognize the hæmoglobin. Thus for the first time two respiratory pigments have been found in one blood. This duplicity is characteristic of the genus *Serpula*, for it occurs in both the species which I have been able to examine, namely, *S. vermicularis* L. and *S. lobiancoi* Rioja. We have here a chemical generic character that will have to be taken into account by taxonomists; it is comparable with chemical specific characters which the respiratory pigments have already furnished[2].

In one genus only of the Serpulimorpha have I found a respiratory pigment in tissue cells: *Potamilla*, with only chlorocruorin in the blood, has hæmoglobin in its muscles. Just as in the case of mammalian myoglobin, the wave-length of the α-band axis of the hæmoglobin in *Potamilla* muscle is longer than that of the mammalian blood pigment. The muscles of *P. reniformis* (O. F. Müller) are pink with hæmoglobin, whereas those of *P. stichophthalmos* (Grube) have just a little of the pigment. As the two species live side by side in the same stones, again the pigment difference does not seem functional.

The hæm of chlorocruorin is spectroscopically different from protohæm, the hæm of hæmoglobin[3]. Most animal cells contain protohæm[4], whether or not the animals possess hæmoglobin. It is therefore of particular interest to know if animals with chlorocruorin in their blood have protohæm or chlorocruorohæm in the cells of the various tissues of the body. I have studied this question in the Serpulimorpha, particularly in the largest member of the group, *Sabella spallanzanii* (Viviani), previously known as *Spirographis*[5]. By adding pyridine and measuring the hæmochromogen α-band I find that protohæm alone is present in the tissues; it is found in muscles, tube-forming glands, gut wall, nephridia, eggs and sperm. Chlorocruorin, which is in solution in the blood, has never been found in a cell, and its hæm, too, is absent from the cells of Serpulimorpha. Evidently chlorocruorohæm must be formed from protohæm somewhere in the blood system. This conversion has been accomplished *in vitro*[6]. Chemically it is not a big change: one of the two vinyl groups attached to the 4-pyrrol ring of protohæm is oxidized to a formyl group[7]. Cytochrome is widespread in animals[8], and since the hæms of cytochrome *a* [9] and of cytochrome oxidase[6] are very close to chlorocruorohæm, a similar oxidation of the all-pervading protohæm may take place in many animal cells. Incidentally, in the Serpulimorpha I have found no cytochrome.

In the lumen of the gut of serpulids there is a pigment in solution which has a protohæmochromogen spectrum. It recalls helicorubin in snails, and the gut hæmochromogen of *Daphnia*[10]. Presumably it is derived from the protohæm compound in serpulid tissues. What, then, if any, is the breakdown product of chlorocruorin in the blood? Is the chlorocruorohæm again reduced to protohæm, to swell the gut hæmochromogen?

Protohæm is also present in the mucoprotein tube of *Sabella* and in the membranous lining of the calcareous tube of *Protula*. This recalls the presence of chlorocruorin in the mucous jelly tube of Myxicola[3]. What other cases, except pathological ones, are known of the excretion, either into the gut or in skin secretions, of hæm compounds as such—that is to say, not broken down to bile pigments or porphyrins?

A full account of this work, most of which was done at the Zoological Station of Naples, will be published soon.

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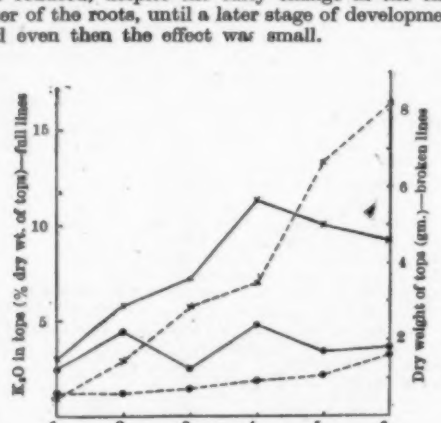
Effect of 4-Chloro-2-Methyl Phenoxyacetic Acid on the Mineral Content and Growth of Plants

Templeman and Sexton[1] have shown that certain concentrations of the aryloxyacetic acids produce a differential effect on the growth of plants of different species. This effect, very marked in the case of 4-chloro-2-methyl phenoxyacetic acid, has now been utilized as a means of eliminating weeds from cereal crops.

We began a study of the mode of action of 4-chloro-2-methyl phenoxyacetic acid on plant growth in 1946. As a result of field experience, rape and spring oats were selected as examples of susceptible and resistant crops, and corn chamomile for intermediate response. Seedlings of the three species were grown in small pots containing silver sand, surface-watered with 40 ml. of nutrient solution (*p*H 6) per pot, once or

twice daily according to weather conditions. After three to four weeks, certain pots began to receive nutrient solution to which sodium 4-chloro-2-methyl phenoxyacetate had been added at various concentrations up to 0·5 parts per million, estimated to be the maximum concentration which the most susceptible species could survive. For the following six weeks a given number of pots from each treatment was withdrawn at weekly intervals for examination. The results were as follows.

(i) Rape (*Brassica campestris*). This species was highly susceptible. Chlorosis of the foliage, swelling of the hypocotyl and root tips, presence of adventitious roots and a less fibrous appearance of the roots were marked after only seven days treatment at 0·5 p.p.m. A similar effect was noticeable on the roots after thirty-five days with the concentration so low as 0·05 p.p.m. This was followed by a reduction in top growth (as evidenced by a comparison of the dry weights of treated and untreated plants), very marked at 0·5 p.p.m. and somewhat smaller at 0·1 p.p.m. The proportion of potassium in the tops, which in the untreated plants rose rapidly during the first four weeks under investigation and thereafter remained fairly constant (in spite of increasing dry weight), was restricted in the treated plants to little more than its original low level (see graph). The proportions of phosphorus and magnesium showed no corresponding diminution. The rate of root-growth (as evidenced by a comparison of the dry weights of treated and untreated plants) was not reduced, despite the early change in the character of the roots, until a later stage of development, and even then the effect was small.



CHANGES IN DRY WEIGHT AND K_2O CONTENT OF TOPS WITH TIME IN RAPE PLANTS TREATED WITH SODIUM 4-CHLORO-2-METHYL PHENOXYACETATE AT 0·5 p.p.m.

×——×, K_2O content of control
●——●, " after treatment
×- - - -×, dry weight of control
●- - - -●, " after treatment

(ii) Corn Chamomile (*Anthemis arvensis*). This species was moderately susceptible. Characteristic changes in the morphology of the roots and hypocotyl appeared after seventeen days of treatment at 0·5 p.p.m. This was followed by a reduction in top growth (not so marked as in rape) at 0·5 p.p.m., but was scarcely appreciable at lower concentrations. The proportion of potassium in the tops of both treated and untreated plants showed no marked differences (the plants treated at 0·5 p.p.m. gave some indication of a lower proportion of potassium), only falling slightly during the experiment in spite of a 27-fold increase in dry weight. There were no marked differences in the proportions of phosphorus and magnesium and the rate of root-growth was unaffected.

(iii) Spring Oats (Variety "Victory"). This species was most resistant. The roots were unaffected until 28 days after commencement of the 0·5 p.p.m. treatment, and subsequent diminution of top growth was quite negligible. Despite a tenfold increase in dry weight during the period of the experiment, the proportion of potassium in the tops of both treated and untreated plants remained roughly constant. The proportions of phosphorus and magnesium and the rate of root-growth were also unaffected.

Thus, the results show that the sodium salt of 4-chloro-2-methyl phenoxyacetic acid markedly interferes with the potassium metabolism of the most susceptible species. The nature of this interference and its possible bearing on the causes of the selective phytocidal action are now being investigated.

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[1] Templeman, W. G., and Sexton, W. A., *Proc. Roy. Soc.*, B, 133, 300 (1946).

Structure of Dimethylnitramine

ALTHOUGH they are of considerable interest from the point of view of valency theory, aliphatic nitro-compounds have hitherto been very little studied by X-ray analysis, and nitramines, so far as we are aware, not at all. We have now made a crystallographic study of dimethylnitramine and find that the molecule is flat with a considerable amount of double-bond character in the N—N bond.

Dimethylnitramine is monoclinic with $a = 6·13$, $b = 6·48$ and $c = 6·08$ A.; $\beta = 114° 33'$. There are two molecules of $(CH_3)_2N.NO_2$ in the unit cell (density 1·36 gm./cm.^{3}). The systematic absences of X-ray reflexions show that the space-group is either $P2_1$ or $P2_1/m$, and as the crystals show no pyro-electric effect the latter is more probable, so that the molecule probably possesses a plane of symmetry.

Examination of rotation and oscillation photographs about the b-axis shows that the sequence of intensities along the zero layer line (planes $h0l$) is exactly paralleled by the sequence along the second layer line (planes $h2l$), while the intensities on the first and third layer lines also agree in every detail. This result can only be explained on the supposition that all the atoms lie in two parallel planes $\frac{1}{2}b$ (that is, 3·24 A.) apart, and this can only be so if the molecules are completely flat. More detailed study of the intensities gives no evidence of the smallest deviation of any atom from the one plane; and it seems reasonably certain that all the atoms of the molecules (other than hydrogen, which are presumably distributed statistically) lie on planes of symmetry parallel to (010) in accordance with one of the two alternatives permitted by the space-group $P2_1/m$. It may be noted that the optical properties agree with this conclusion, the minimum index (1·41) being parallel to the b-axis.

If the N—N bond were single, it would be expected that the three bonds N—N, N—C_1 and N—C_2 would

be disposed approximately tetrahedrally and certainly not in a plane. The foregoing result therefore suggests that the N—N bond possesses a certain amount of double-bond character, and this is supported by the inter-atomic distances which we have obtained. A large number of X-ray reflexion intensities have been measured, and preliminary Fourier syntheses carried out; the bond-lengths derived from them (all accurate to about ± 0·05 A.) are as follows:

N—O = 1·25, N—N = 1·26 and N—C = 1·46 A.

We prefer to postpone discussion of the theoretical significance of the results until further measurements have enabled us to improve the accuracy of the bond-length determinations; but we emphasize that the value of the N—N bond-length differs from the single bond-length by very much more than the experimental error.

This work was done in the Chemistry Department of the University of Birmingham during 1940–41, under a Ministry of Supply extra-mural contract, and while one of us (W. C.) was the holder of a Fenwick Scholarship and a Brotherton Scholarship; we are indebted to the Chief Scientist, Ministry of Supply, for permission to publish this note.

In the course of the work the numerous trial and error calculations which were necessary before syntheses could be carried out were much expedited by means of a special structure-factor calculating machine devised by one of us[1] and now being improved and rebuilt with the aid of a grant from the Royal Society.

Additional measurements on dimethylnitramine are now being made in order to determine the bond-lengths with the highest possible accuracy, and the work is being extended to compounds containing similar bonds.

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Aug. 27.

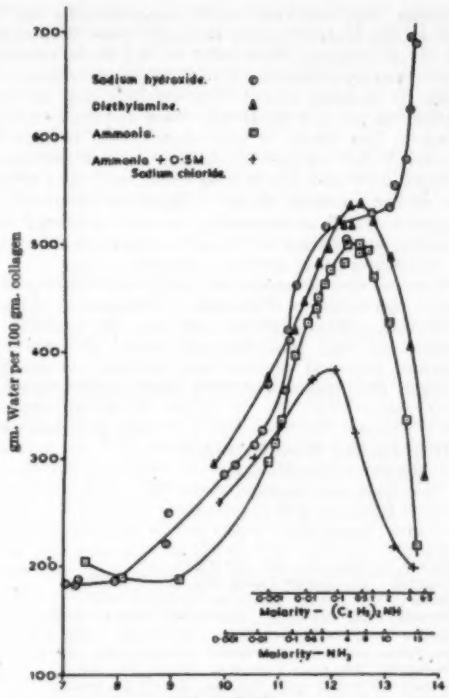
[1] Briefly described by E. G. Cox in the discussion on a paper by Beevers, C. A., *Proc. Phys. Soc.*, **51**, 666 (1939).

Uptake of Water by Collagen in Solutions of Alkalis and Strong and Weak Organic Bases

The swelling of collagen and other structured proteins in solutions of strong acids takes place in accordance with the Donnan theory of membrane equilibrium[1,2,3]. Lyotropic effects of anions[4,5] and effects due to fixation of the anions by the protein[6,7,8] can also be observed.

At *p*H values below about 3·0, the water uptake is greater with weak than with strong acids, and the decrease at lower *p*H values is no longer apparent[5,9]; this effect may be attributed to the action of the undissociated acid on the cohesion of the protein[9,10].

We find that swelling in alkaline solutions at 20° is more complicated. With the strong bases sodium hydroxide and tetramethyl ammonium hydroxide, the water uptake of skin collagen does not decrease at high *p*H values as predicted by the Donnan theory, but after increasing less rapidly with rise in *p*H in the range 11·5–13, it increases again sharply as the *p*H is further increased (see graph). (It has been established that the guanidine groups in collagen do not begin to titrate below *p*H 13·5 and hence cannot be responsible for this increase in water uptake.) With the weak bases ammonia and diethylamine, the water uptake changes over the whole *p*H range covered in accordance with the Donnan theory. (The observed *p*H values plotted in the graph were determined using the special Beckman glass electrode; when the concentration of base is high and the activity of water is appreciably less than 1, the observed *p*H values will begin to differ from the true values[11].)



WATER UPTAKE OF SKIN COLLAGEN IN AQUEOUS SOLUTIONS OF ALKALIS AT 20° C.

These results cannot wholly be explained either on the basis of the Donnan theory, or of a specific cation effect. Although there is some indication that the sodium ion may have a specific effect in decreasing cohesion (see below), this effect is small compared with the effects now observed at high *p*H values; and the addition of sodium chloride does not alter the shape of the ammonia swelling-curve, but depresses the water uptake in accordance with the Donnan theory. It must be concluded, therefore, that the increased water uptake occurring at high values is associated with the presence of a high concentration of hydroxyl ions, which by some mechanism, probably breaking of hydrogen bonds, decreases the cohesion of the collagen and so allows it to take up more water. Since this effect is not operative with the weak bases, ammonia and diethylamine, it would appear possible that the presence of undissociated base in some way inhibits the action of the hydroxyl ions on cohesion.

We find that the addition of sodium chloride does not depress the water uptake in alkaline solutions to the same extent as in acid solutions, and conclude that under these conditions the sodium ion or the salt itself decreases the cohesion of the collagen. On the addition of sodium chloride to calcium hydroxide

solutions, we find that with concentrations up to 0·05 *M* the water uptake increases with increasing salt concentration, from 0·05 to 0·5 *M* it remains approximately constant, and at higher concentrations begins to decrease again. We conclude that at concentrations up to 0·05 *M* the water uptake increases owing to the effect of the monovalent sodium in increasing the osmotic swelling; at concentrations between 0·05 and 0·5 *M* this effect, and that of the salt on the cohesion of the collagen, is balanced by the effect of salt in depressing osmotic swelling; and at higher concentrations the water uptake is decreased by the dehydrating action of the salt.

We have also observed that under conditions which reduce the cohesion of collagen, for example, sodium hydroxide solutions above *p*H 13, the addition of organic solvents miscible with water, for example, acetone, *n*-propyl alcohol and dioxan, causes the collagen to disperse and to a large extent dissolve.

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Aug. 18.

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Effect of Cetyl Pyridinium Bromide on the Water Absorption and Swelling of Soil

Surface-active quaternary ammonium salts containing a long-chain paraffin group find a number of technical and medical uses due to their adsorption by textiles, bacteria, etc. It has now been found that the adsorption of such compounds by clay particles affects the water absorption and swelling characteristics of soils.

Experiments have been made with a clay loam soil from Harmondsworth, containing 28 per cent of particles having equivalent diameters smaller than 2 μ. This soil was treated with hydrogen peroxide to remove organic matter and then leached with 0·2 *N* hydrochloric acid to saturate the clay fraction with hydrogen. Groups of four cylinders were then prepared to a constant volume, 1 in. high and 1 in. in diameter, constant weights of mineral matter and of liquid being used in the preparation of each cylinder. Amounts ranging from 0 to 1·0 per cent of a commercial form of cetyl pyridinium bromide were added to the different groups of cylinders, the salt being incorporated in the water added. After preparation, the average moisture content, bulk density and air-voids content of all the specimens was 12 per cent, 1·9 gm./c.c. and 14 per cent respectively. The cylinders were then allowed to stand in a humid atmosphere for three days to permit conditions of equilibrium to be established. After this time the circular surfaces of the cylinders were given a thin coating of paraffin wax, and they were allowed to take up water by standing on saturated sand contained in 100 ml. beakers.

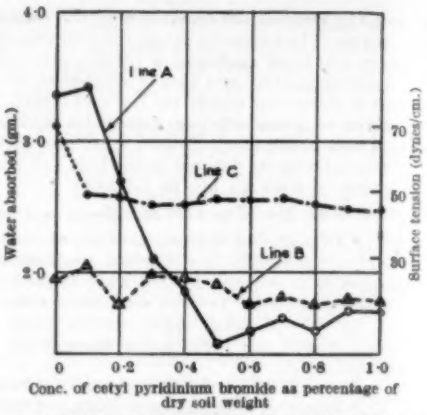

Fig. 1. Effect of cetyl pyridinium bromide on the water absorption of Harmondsworth clay loam soil

Line *A*, experimentally determined water absorption; line *B*, theoretical water absorption to saturate specimens, assuming no swelling; line *C*, surface tension of cetyl pyridinium bromide solutions of equivalent concentrations

Fig. 1 shows the amounts of water absorbed by the different batches of specimens after 16 hr., each point being the average result obtained from four determinations (line *A*). The dotted line (line *B*) indicates the calculated amounts of water required to fill the air-voids in the cylinders, assuming that the latter do not increase in volume. The same diagram shows the surface tension of aqueous solutions of cetyl pyridinium bromide, at concentrations equal to those at which the salt was present in the soil-water (line *C*).

It will be seen that there is a marked reduction in the water absorption between 0·1 and 0·5 per cent concentration, the reduction being about 57 per cent. The values of the surface tension between the same equivalent concentrations show no such uniform reduction, the variation being about ± 2 per cent. It is concluded that the reduction in the water absorption indicated by line *A* is not due to a reduction of the surface tension at the air/water interface. Beyond a concentration of 0·5 per cent cetyl pyridinium bromide, there is no further marked reduction in the water absorption, the values reflecting to some extent the volumes of the air-voids in the soil.

It was concluded from this experiment that the addition of cetyl pyridinium bromide to a clay soil will not prevent the movement of water through the pore spaces of the soil, but will inhibit the adsorption of water by the clay particles, and hence the swelling of the latter. More direct evidence for this view is provided by a second experiment, in which measurements were made of the linear swelling of the soil when treated with the same concentrations of the salt.

Flat cylindrical specimens, 2 in. in diameter and 0·5 in. high, were made up at a moisture content of 17 per cent and bulk density of 1·9 gm./c.c. They were compacted between filter papers into brass moulds having perforated bases through which water was allowed to come into contact with the soil. A dial-gauge, reading to 0·001 in., was fitted to the moulds to record the vertical movement of brass cylindrical plates resting on the specimens.

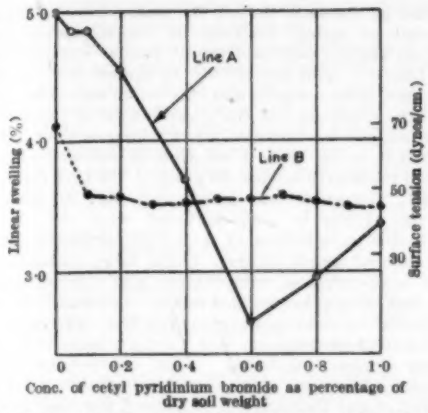

Fig. 2. Effect of cetyl pyridinium bromide on the swelling of Harmondsworth clay loam soil

Line *A*, experimentally determined swelling; line *B*, surface tension of cetyl pyridinium bromide solutions of equivalent concentrations

Fig. 2 shows the linear swelling of the soil specimens, expressed as a percentage of the original height, plotted against the concentration of cetyl pyridinium bromide (line *A*). Each point gives the average value of duplicate determinations. The curve relating surface tension and concentration for aqueous solutions of the salt is reproduced again (line *B*) for comparison. The swelling curve has a similar form to the water absorption curve shown in Fig. 1, except that the swelling reaches a minimum value at 0·6 per cent, after which a steady increase takes place to 1·0 per cent. The maximum reduction of swelling obtained is 48 per cent of the original value for the untreated soil.

It was found in earlier unpublished work that the treatment of soil with an aqueous solution of cetyl pyridinium bromide reduces the heat of wetting. It is considered that the reduction in swelling and water absorption demonstrated in the above experiments may be due to the adsorption of cetyl pyridinium ions on the surfaces of the particles of the clay fraction, which is the component responsible for the swelling properties of a soil, thereby reducing their tendency to hydrate.

I am indebted to Miss O. M. Powell, who carried out the experimental work.

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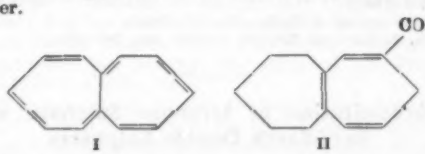
Synthesis of Cyclic Conjugated Polyolefins

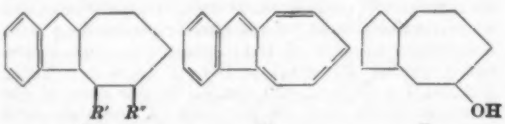
Considerable interest is attached to the properties of cyclic conjugated polyolefins[1], and in a number of studies we have been exploring possible routes to analogues and derivatives of such mono- and bi-cyclic structures as those of cyclo-octatetraene and azulene. In attempts to prepare the azulene analogue (I), for which the name 'heptalene' is suggested, the ethyl (0 : 5 : 5)-bicyclo-duodecatriene carboxylate (II) was submitted to vapour-phase dehydrogenation by the method of Linstead, Millidge, Thomas and Walpole[2]. The main product of this reaction, however, was a mixture of dimethyl-naphthalenes, formed through rearrangement of the carbon skeleton. In an attempt to prevent such rearrangement, a higher speed vapour-phase dehydrogenation technique was evolved, which allowed very brief contact with the catalyst and rapid removal of the products from the zone of the reaction. Under these conditions the product of reaction was a deep blue oil from which azulene-like material was extracted in small yield with 85 per cent phosphoric acid, and regenerated from solution by addition of water.



I II

This product could be saponified to yield a green sodium salt. A study of its visible absorption spectrum has shown it to have strong absorption maxima at 700, 632, 605 and 580 mμ, and weak absorption maxima at 734, 676, 662 and 651 mμ. These spectral characteristics are very similar to those of 2-ethyl-6-carboethoxy-azulene[3], which shows strong maxima at 668·5, 608·5, 563 (broad band) and weak maxima at 643, 630·5, 619, 586 and 575·5 mμ. Even the best yields of the blue dehydrogenation product have, however, so far been too small to allow of its purification and characterization; and whether a heptalene structure has been produced, or whether an azulene has been formed as a result of a rearrangement reaction, remains to be proved. In either case, however, our experiments to date are significant in that they demonstrate that the heptalene structure is not one which can be generated by dehydrogenation with the same facility as that of azulene. That a careful study of dehydrogenation conditions is essential in the exploration of syntheses of this type is indicated by other experiments.

Thus, when a mixture of carbinols (III; $R' = H$, $R'' = OH$ and $R' = OH$, $R'' = H$) was heated with palladium/charcoal at 300° C. for several hours, only a brown resinous substance was produced which gave no addition product with 2 : 4 : 6-trinitrotoluene. Cook, McGinnis and Mitchell[4] have reported a similar failure to prepare 5 : 6-benzazulene by this method. In our hands, dehydrogenation by the method of Linstead *et al.*[2] was equally unsuccessful; but when a higher-speed dehydrogenation was used, there was produced in the first few minutes a trace of a colourless crystalline substance of m.p. 94–97° C. (almost certainly phenanthrene), and this was followed by distillation of an intensely deep blue oil. This yielded 1 : 2-benzazulene (IV) as deep green plate-like crystals on contact with alcohol. It could be recovered unchanged from its solutions in 85 per cent phosphoric acid, and was readily characterized by the formation of a trotylate.



III IV V

The higher-speed dehydrogenation method has also been used by us with advantage for the production of azulene from V, the yields obtained being higher than those by other dehydrogenation techniques. Its

applications above, as well as to a variety of other structures, will be published in detail elsewhere.

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Coprecipitation of Uranous Sulphate with Rare-Earth Double Sulphates

Since uranous sulphate forms no double sulphate with sodium sulphate or the rare-earth sulphates which is insoluble in water or dilute sulphuric acid, it might be expected that tetravalent uranium would pass into the filtrates when the cerium group is separated from acid solutions of the sulphates as the double sodium sulphates. Certain cations not necessarily tripositively charged, for example, Th^{4+}, the ionic radii of which are close to those of the cerium group elements[1], tend to be coprecipitated when this group is separated as double sodium sulphates[2], although no corresponding insoluble double sulphates are known. The radius of the uranous ion, however, is almost equal to that of yttrium[1], so there is added reason to expect tetravalent uranium in the soluble double-sulphate fractions. It has been found, on the contrary, that uranous sulphate in acid solution is either partly or wholly precipitated with cerium and the cerium group elements, the extent of coprecipitation depending mainly on the concentration of uranous and rare-earth ions. When the uranium concentration is sufficiently high, a pale green precipitate is obtained, the colour of which is more evident in artificial light.

The following figures were obtained by stirring anhydrous sodium sulphate into a solution of the composition: Ce_2O_3, 32 gm./l.; UO_2, 3·4 gm./l.; H_2SO_4, 106 gm./l., and filtering after standing 30 min. at 20° C. Uranous sulphate was prepared by electrolytic reduction of uranyl sulphate at a lead cathode, air being blown through the solution before mixing in order to oxidize trivalent uranium[3].

Mol. Na_2SO_4 per mol. of Ce_2O_3	1·1	2·2	3·2	4·3	5·4	6·5
Ce_2O_3 precipitated, per cent	72	96	97	97	98	99
UO_2 coprecipitated, per cent	34	71	85	92	95	97

When 6 mol. of sodium sulphate per mol. of Ce_2O_3 were added to a solution of the composition: Ce_2O_3, 24 gm./l.; UO_2, 23 gm./l.; H_2SO_4, 200 gm./l. under the same conditions as before, 80 per cent of the uranous oxide and 99·8 per cent of the cerous oxide were precipitated. The weight fraction uranium oxide to uranium + cerium oxide in the precipitate was approximately 0·43. In a similar experiment with a sulphate solution of the composition: mixed rare-earth oxides, 27 gm./l.; UO_2, 2·7 gm./l.; ThO_2, 3·2 gm./l.; H_2SO_4, 130 gm./l., 98 per cent of the uranous oxide and 98 per cent of the rare-earth oxides were precipitated by 6 mol. of sodium sulphate.

An almost quantitative precipitation of uranous ion can thus be obtained at a rare-earth oxide concentration of not less than 24–32 gm./l., provided that 98 per cent or more of the rare earths are precipitated and that the ratio of uranous oxide to rare earth oxides in solution is 0·1 or less. No significant amount of uranyl sulphate is coprecipitated with sodium cerium sulphate under similar experimental conditions. The precipitate is appreciably soluble in water, both uranous and rare-earth sulphates passing into solution; but the green colour of the precipitate cannot be removed by washing with water.

Earlier work[3] with a solution of the composition: mixed rare-earth oxides, 30 gm./l.; ThO_2, 3·6 gm./l.; H_2SO_4, 109 gm./l. has shown that only 46 per cent of the thoria is coprecipitated with the double sulphates by addition of 6 mol. of sodium sulphate per mol. of mixed oxides. Quite large variations in acid concentration, temperature and time of standing had little effect on this result. There is thus only a qualitative resemblance between the coprecipitation of tetravalent uranium and thorium ions with rare-earth double sulphates. The coprecipitation of thorium, however, is more understandable, since the radius of the thorium ion is some 5 per cent greater than that of the uranous ion and is approximately equal to that of gadolinium.

Although adsorption may play a part in the coprecipitation of uranium and thorium with sodium rare-earth sulphates, it is clear that other factors are involved besides ionic size or ionic charge and the solubility of the double sulphates in the system water – sodium sulphate – sulphuric acid. These must ultimately be traced to the different electronic structures of uranous, thorium and rare-earth ions.

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Variation in Density of Cerium Oxide

The existence of polymeric varieties of cerium oxide was proposed so long ago as 1897[1], this contention being based, *inter alia*, upon the fact that the colour of the oxide is dependent, not only on its purity, but also upon the nature of the salt from which it is prepared by ignition. Although density figures quoted in standard text-books show obvious variation, I have been unable to trace any data correlating the density of cerium oxide prepared in different ways with the possibility of its existence in polymeric forms.

My starting material was cerium oxide of higher than 99·5 per cent purity, the remaining less than 0·5 per cent being other rare earth oxides. This was converted to sulphate with hot concentrated sulphuric acid, and then obtained in solution by diluting with water. Different portions of the sulphate solution thus obtained were then precipitated as oxalate, double sodium sulphate, and as hydroxide with ammonia. Two oxalate precipitates were converted to hydroxide and carbonate by digestion respectively with sodium hydroxide and carbonate; likewise with the double sodium salts. The carbonates and hydroxides were filtered off and washed free of alkalis and soluble salts. One oxalate precipitate was ignited as such, and a further portion of the initial sulphate solution evaporated to dryness and the sulphate thus obtained ignited. All specimens—hydroxides, carbonates, oxalate and sulphate—were

ignited gradually and finally at 1,200° C. for 1 hour to ensure complete conversion to oxide.

The cold oxides were then passed through a 100-mesh screen and their densities determined pyknometrically against water at 25° C. Although exceptional accuracy was not aimed at in the density determinations, the results were all obtained under the same conditions, so that, although the values obtained may not be specific, their interrelationship is the same.

		Density	Colour
Oxide 1	Ignition of oxalate	6·64	Light salmon
3	Ignition of hydroxide from double sulphate	6·63	Light salmon
5	Ignition of carbonate from oxalate	6·52	Buff
2	Ignition of hydroxide	6·51	Buff
4	Ignition of hydroxide from oxalate	6·32	Natural
7	Ignition of sulphate	6·27	Light natural
6	Ignition of carbonates from double sulphate	6·03	Yellow

It will be seen that, within experimental error, four oxide forms can be differentiated: oxides 1 and 3; 5 and 2; 4 and 7; and 6; with average densities of 6·635; 6·515; 6·295; and 6·03, respectively. Although it is obvious that the mode of preparation of the oxide, namely, crystal structure and particle shape of the parent compound, influences the density of the product, it is not possible to determine any sequence for this.

If it can be accepted, however, that the polymeric forms of cerium oxide, $(CeO_2)_{40}$, $(CeO_2)_{16}$, and $(CeO_2)_8$, do exist[2], and that these may be differentiated, as may most polymers, by their densities, then it is considered probable on the basis of the above figures that a fourth polymeric form of cerium oxide exists.

X-ray analysis could no doubt verify, or otherwise, this possibility, but in the absence of the necessary equipment for this work, further investigations are being undertaken on this subject from the chemical aspect.

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Age of the Baker's Hole Coombe Rock, Northfleet, Kent

Prof. W. B. R. King and Dr. K. P. Oakley discussed this subject in *Nature* of January 13, 1945 [1].

In my opinion the Montières Coombe Rock is Riss I plus Riss II, with Levallois I and II *without any trace of Acheulean*. The coombe rock of Baker's Hole contains a Levallois with large flakes plus bifaces which, according to King and Oakley, resembles my Levallois V industry of broad but not too thick flakes, and abundant heart-shaped and triangular bifaces. Their opinion is probably right, and for some years I have suspected my mistake; but there are two solutions. If, as I am led to believe (without personally being able to control the Northfleet Coombe Rock), Baker's Hole is really Rissian, one must explain the difference in the industries between Montières and this English site.

When I first set forth my views on this subject, my knowledge of the industry of Northfleet and the various French and English Levallois levels was incomplete. In England the true Old Levallois exists in a solifluxion layer at Bapchild, Kent[2]; but it is not the same as that of Northfleet, which is analogous to our Levallois V. In France the Levallois V is not derived from Levallois IV. It may be that, while we had our Levallois III–IV, England had already reached a Levallois stage more or less Levallois V, and that during the low sea-level of the Würm it crossed over to France, driven out of the northern islands by the Würm I glaciation. If the coombe rock of Baker's Hole is Würm, as in France, the Levallois V should be on (not in) the solifluxion gravel; but the contrary is the case in Baker's Hole, where the Levallois is below the coombe rock, which is evidence for making the origin of our French Levallois V a little later.

The same thing applies to the French Levallois III–IV, which is similar to the Markkleeberg industry shown by Grahman to be not Riss–Würm but Mindel–Riss. During the Riss this latter was probably driven back from Germany towards the west, England included. The same industrial stations may, therefore, alternate between the zones of the big glacial extensions and the western zones of less severe climatic conditions, and have taken advantage of the low sea-level draining the Channel at each maximum glaciation.

Let us now return to the Acheulean types of Swanscombe referred to as *superior*, that is to say, Acheulean IV–VII of the Somme. The answer is that in France during the Mindel–Riss the limande (ovate) is the dominant type until the end of Acheulean III (with always sporadic pointed pieces which become more numerous towards the end of Acheulean III and with the appearance, as at Swanscombe, of a few small pieces of Levalloisian technique). In all of the Mindel–Riss deposits at Swanscombe, there are types which are generally found in France in the inter-Riss: Acheulean IV, which is Commont's workshop-level, and which continues after the Riss II (Old Loess with Acheulean V) and finally in the red fissured clay of the Riss–Würm of the 30-metre terrace. This is probably a phenomenon of precession and migration.

Under these conditions, regional differences should not cause surprise. Only careful and *objective* observations can in time lead us to establish these regional differences, which are due to glacial extensions and concomitant continental connexions, alternating between England and the rest of Europe with high sea-levels re-occupying the English channel and the North Sea.

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Dependence of Anomaloscope Matching on Viewing Distance or Field Size

I read with great interest the letters of Mr. R. G. Horner and Mr. E. T. Purslow and of Dr. J. H. Shaxby[1], in which they describe the changes which have to be made in the red and green mixture required to match a given yellow, as the visual angle is altered. They remark, "It is more surprising that such effects should extend to angular fields between 1° and 3° . . ." I have recently confirmed their conclusion and have found that the effects extend

to angular fields of between 5° and 25°. I have also performed some additional experiments in an attempt to elucidate the cause of the effect.

Some colour filters were prepared, the properties of which are shown in Table 1.

TABLE 1. SPECTRAL TRANSMISSIONS OF COLOUR FILTERS

Class of filter	Series 1	Series 2	Series 3	Series 4
Dichromatic	0·69μ and 0·55μ	0·69μ and 0·53μ	0·69μ and 0·51 μ	0·69μ and 0·50μ
Monochromatic	0·580μ	0·575μ	0·570μ*	—*
Wide band Yellow-blue	0·51–0·70μ	0·52–0·68μ	0·52–0·66μ	0·47–0·62μ and 0·565μ and 0·450μ

The dichromatic filters transmitted two narrow spectral bands the mean wave-lengths of which are shown in the table. Each of the monochromatic filters transmitted a single band having the mean wave-length shown. The wide-band filters had a broad transmission which occupied a position in the spectrum between the wave-lengths indicated. Four series were prepared, and the filters in each series were adjusted to match one another as closely as possible in hue and saturation, at a light intensity of 50 ft. c. and a visual angle of 5°. Satisfactory matching was obtained except in the cases of the filters marked with an asterisk. The failure to obtain an exact match was due to the fact that the dichromatic filter of Series 3 transmitted a cream-coloured light, and in consequence the monochromatic filter was definitely more saturated. The same statement would have applied even more forcibly to the monochromatic filter in Series 4, since the light transmitted by the dichromatic filter of this series was almost white. Instead of a monochromatic filter, a dichromatic yellow-blue filter was prepared having the transmission shown in Table 1.

The filters in each of the series were now viewed in pairs at visual angles of about 1°, 5° and 25°, with the results shown in Table 2.

TABLE 2. COLOUR CHANGES WITH ALTERATIONS OF VISUAL ANGLE

Filters being compared	Series 1	Series 2	Series 3	Series 4
Dichromatic and monochromatic	4	4	4	–
Wide-band and monochromatic	3	2	1	–
Dichromatic and wide-band	1	2	3	6
Dichromatic and yellow-blue	–	–	–	10
Wide-band and yellow-blue	–	–	–	4

The highest score was given where there was a very obvious colour change with alteration of visual angle. Smaller scores were given in accordance with the visual estimate of the amount of the colour change. Comparing the scores in the four series when the dichromatic are compared with the monochromatic filters, it will be observed that altering the wave-length of the green component from 0·55 to 0·50 produces little or no effect on the score. This suggests that some alteration in the blue sensation is not responsible for the effect, for if it were it would be expected that Series 2 would have a higher score than Series 1, and Series 3 a higher score than either. On the other hand, that some alteration in the red sensation may be responsible is suggested by the fact that the scores for both wide-band versus monochromatic, and for dichromatic versus wide-band, are smaller than the scores for dichromatic versus monochromatic. It would be expected that such would be the case if red played an important part, since the dichromatic filters transmit the most red, the monochromatic filters the least red, while the wide-band filters occupy an intermediate position so far as red content in the light transmitted is concerned.

To summarize the facts so far known: (1) with reduction of visual angle, filters which transmit red freely become redder than those which do not, and vice versa; (2) this effect is still found at visual angles as large as 25°.

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A Unified Theory of Spontaneous Electrical Fluctuations in Thermionic Valves

THE phenomena of intrinsic fluctuations of voltage and current in electric circuits are generally regarded as belonging to either of two classes, usually referred to as 'thermal fluctuation' and 'shot effect'. The former, the precise counterpart of the Brownian motion of mechanical systems, has its origin in the irregular thermal movement of the constituent particles of matter; the latter, which occurs in thermionic valves and similar devices, is considered to be essentially due to the electronic structure of electricity.

Although it therefore seems that the two phenomena are of an entirely different nature, it has frequently been pointed out that they become identical in certain circumstances[1]. Theoretical considerations have led me to the conclusion that not only in such limiting cases but quite generally the two phenomena are, in fact, only two aspects of one and the same statistical fluctuation process, which can be theoretically treated by the application of the principles of statistical thermodynamics. By following this line of approach, it becomes possible to derive, in a much simpler way than by the established theories, an approximate formula for the shot effect in diodes which covers the whole range of the characteristic. A detailed paper on this investigation is being published elsewhere. Here the main resulting formula only is given, and its application to some special cases discussed.

Let I be the mean current through the valve, V_a the applied anode potential, I_s the saturation current for the filament temperature T, e the magnitude of the electronic charge, and k Boltzmann's constant. Then the mean square of the fluctuation of current, within the interval Δf of the 'frequency spectrum' of that fluctuation, is given by

$$\overline{(\delta I)^2} = 2kT\Delta f \cdot \frac{g_c^2 + g_a^2}{g_c + g_a}, \qquad (1)$$

where

$$g_a = \left(\frac{\delta I}{\delta V_a}\right)_{I_s} \qquad (2)$$

is the differential valve conductivity; and

$$g_c = \left(\frac{\delta I}{\delta I_s}\right)_{V_a} \cdot \frac{eI_s}{kT}. \qquad (3)$$

In the so-called 'retarding field region' (with negative 'anode' potential), where

$$I = I_s \exp\left(\frac{eV_a}{kT}\right),$$

one has from (2) and (3)

$$g_a = g_c = \frac{eI}{kT};$$

hence formula (1) becomes

$$\overline{(\delta I)_f^2} = 2eI\Delta f. \qquad (4)$$

It was shown by D. K. C. MacDonald and me that this formula is indeed strictly valid in the retarding field region[2].

In the so-called 'space-charge limitation' region (at the lower bend of the characteristic) one would expect $g_c = 0$ as, according to the Langmuir–Child relation, I should be independent of I_s. This immediately leads to

$$\overline{(\delta I)_f^2} = 2kTg_a\Delta f. \qquad (5)$$

The same relation follows generally for $g_a = g_c$. In any case within this region $0 \leqslant g_c/g_a \leqslant 1$; thus, according to (1), the fluctuation formula can be written in the form

$$\overline{(\delta I)_f^2} = 2eI\Delta f \cdot \Gamma^2, \qquad (6)$$

where the 'space-charge reduction factor' Γ^2 is given by

$$\Gamma^2 = \lambda \frac{kT}{eI} g_a, \qquad (7)$$

and λ is a constant of the order of magnitude unity. This result is also in agreement with experiment[3].

Finally, in the saturation region where $I = I_s$ is independent of V_a, one has $g_a = 0$, and consequently one obtains Schottky's classical shot effect formula in the form (4).

It has been argued[1] that a diode with two hot electrodes at the same temperature T (double diode) should be equivalent to a 'resistance' $1/g_a$ of the same temperature, and hence the fluctuation should obey Nyquist's thermal fluctuation formula, that is, formula (5) with a factor 4 instead of 2. In order to check this prediction, fluctuation measurements in double diodes were carried out, on my suggestion, by D. K. C. MacDonald some time ago[4], with the result that the relation was satisfied for low temperatures only, and that the ratio between measured and calculated fluctuation increased steeply with increasing temperature. This unexpected result can be immediately understood in the light of the present theory without any further assumptions. For it follows from the theory that formula (1) should also hold for a double diode when the factor 2 is replaced by 4. Thus one obtains the fluctuation formula

$$\overline{(\delta I)_f^2} = 4kTg_a \frac{1+\alpha^2}{1+\alpha} \Delta f \qquad (\alpha = g_c/g_a). \qquad (8)$$

This coincides with Nyquist's law only for $\alpha = 0$ and $\alpha = 1$ (and approximately within these limits), but predicts increasingly larger fluctuation values for increasing values of α. From the valve data kindly supplied to me by Dr. MacDonald, it follows, indeed, that α is of the order of magnitude unity up to filament temperatures of about 2,100° K., and from there on increases rapidly with increasing temperature; this is in satisfactory agreement with the fluctuation measurements mentioned.

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Production of High-Frequency Energy by Ionized Gases

SINCE the publication in this journal[1] of a note by P. C. Thonemann and R. B. King, entitled "Production of High-Frequency Energy by Ionized Gases", a large number of experiments have been made in this laboratory on the noise and oscillations in cold-cathode and hot-cathode discharge-tubes, when placed in a transverse magnetic field[2]. Our experiments were carried out with nitrogen at a pressure varying from 1 to 50 μ mercury in cold-cathode discharge tubes. The greatest care was taken to localize the magnetic field of an electromagnet, to hold constant the pressure at a fixed level and to purify the gas (spectroscopically pure nitrogen).

The work was done with a superheterodyne receiver covering the range from 1·30 to 2·60 metres, coupled by small condensers to the cathode or the anode on one side, and to a Langmuir probe on the other side. The probe was constructed as described by F. D. Greeves and J. E. McF. Johnston[3] and J. L. Spencer-Smith[4]. Six probes were placed in the discharge, each one along a diameter of the circular section of the tube, and movable by means of a magnetic coil.

The noise occurred only when the magnetic field was applied near the anode of the tube. It fell to less than 10 μV. when the magnetic field was applied near the cathode or near the probe. When the electromagnet was moved from the neighbourhood of the anode, the noise decreased rapidly. This result is very different from that reported by Cobine and Gallagher[5] when working on wave-lengths greater than 50 metres.

When the tube current and the pressure of the gas were constant, the noise-level increased when the magnetic field increased, reaching a sharp maximum for some fixed value of the field. The noise decreased while the magnetic field was increased further until it reached the value where the discharge was cut off. When the tube current was increased, the magnetic field producing the maximum noise was also increased.

With constant pressure and magnetic field, the noise increased when the tube current continuously increased and reached a certain maximum, then decreased to a very low value. The resulting position of the noise maximum moved towards the heavier currents when the applied magnetic field increased. When the applied magnetic field was held constant, the tube current corresponding to the noise maximum increased when the pressure decreased.

The use of probes at fixed potentials showed that the maximum of noise is produced when the potential of the probe is equal to the local potential in the discharge. This result cannot be explained by changes of space-charge conditions far from the probe studied, for it was shown that the variation of

potential of a probe did not disturb the space-charge conditions near the other probes even when the magnetic field was applied.

Contrary to the results of Cobine and Gallagher[5], a sharp maximum of noise was found when the probe potential crossed the local potential in all the experiments which have been carried out

The Cobine and Gallagher hypothesis and the J. J. Thomson – Langmuir theory of electron oscillations in ionized gases do not seem sufficient to explain the results of these experiments.

A complete account of the present work will appear in due course in the *Revue Scientifique*[6].

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Gyro-interaction of Radio-Waves Obtained by the Pulse Method

In March and April 1946, during fourteen nights, experiments were made by the Institute of Technical Physics of the University of Naples in association with the Institut Elettrotecnico Nazionale of Turin, the Vatican Radio and Italian Navy and Air Force, in order to verify if there is a resonance effect in the interaction of radio-waves (gyro-interaction) according with V. A. Bailey's suggestion of 1937 [1].

For this purpose a method devised by me was used, consisting in varying the frequency of the disturbing station around the local gyromagnetic frequency, to obtain the maximum of the phenomenon. As soon as the maximum was revealed at the receiving apparatus, the frequency of the disturbing station which has produced the maximum was measured by means of a frequency-meter. This measured frequency is very close to the local gyromagnetic frequency. By doing this, it was possible with a power of 700–800 watts to measure the local gyromagnetic frequency $\Omega = eH/2\pi m$, and consequently the value of the total terrestrial magnetic field H in the ionosphere, and also to ascertain a regular variation of the gyro-frequency during the night.

In order to verify the results of those experiments, further investigations were made between January and July 1947, in association with the Italian Navy. The military stations of Augusta (630 m., 1 kW.) and Taranto (1,250 m., 1 kW.) operated as emitters, and Venice, La Spezia, Leghorn and Roma (Sant' Alessandro) as receiving stations. Naples, the wave-length of which varied from 265 to 285 m., operated as disturbing station.

In order to obviate the lack of power of the Naples station (400–500 watts), which, in the first experiments, made observation of the phenomenon very difficult, the pulse-method was applied to this station. The experiments made using the pulse-method have confirmed my suggestion, because, although the power was not much varied, it is believed that the transient is more efficient than a continuous wave in the interaction.

The gyro-interaction was observed frequently, sometimes during a whole hour of transmission, and very easily, notwithstanding the remarkable strength of the atmospheric static. The number of the observations (about forty) obtained in Venice, and often also in Rome, is sufficient to confirm clearly the gyro-interaction. The phenomenon was never observed in Leghorn and La Spezia, perhaps on account of the fact that the reflexion points of the waves of the emitting stations were too far from the 'sky' of Naples. The wave-lengths of the disturbing station which have caused the gyro-interaction are included between 265 and 282 metres. The variation law of the disturbing station frequency was 4 by 4, 2 by 2, and very often 1 by 1 metre. The behaviour of the phenomenon was generally similar to that in 1946 during the three hours of transmission. While in the first hour the gyro-frequency was low, about 282 metres, in the second hour it became higher, about 272 metres or less, and in the third hour about 265 metres. In 1946 and 1947, the interaction was stronger between 0200 and 0300 local time, and less easily observable between 0400 and 0500.

The experiments are being continued with more powerful stations.

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Relativity of Accelerated Motion

According to the general theory of relativity, accelerated motion is relative; that, however, is difficult to reconcile with experimental evidence; for example, in the case of rotation.

The relativity of accelerated motion follows from the general covariancy of physical laws; thus, if $T_a^{\circ} = 0$ (for all four components) represents a physical law in one system of co-ordinates, then in any other system the law is

$$T_\mu = \frac{\partial x_a^{\circ}}{\partial x_\mu} T_a^{\circ} = 0; \qquad (1)$$

that is, it preserves its form.

Laws of physics can therefore give us no information about the system of co-ordinates used; and, since four-dimensional curvilinear co-ordinates correspond to accelerated motion, the latter is purely relative. This difficulty can be explained as follows.

Equation (1) presupposes that (*a*) there is one to one correspondence between the two spaces, (*b*) the transformations $\partial x_a^{\circ}/\partial x_\mu$ remain finite throughout the space; that, however, need not be the case in a transformation between a Galilean and accelerated spaces.

Accelerated motion is equivalent to a gravitational space, and we should expect the latter to have an impenetrable boundary, since otherwise a particle might acquire in it an infinite velocity. For example, in the case of Einstein's gravitational space, the boundary is $r = 2m$. There is, therefore, no one to one correspondence between a Galilean and accelerated spaces.

If a Galilean space can be transformed into an accelerated one, we should expect that on the boundary the transformations $\partial x_a^{\circ}/\partial x_\mu$ would become infinite, and (1) would break down. Unfortunately, there are no solutions for accelerated spaces, except in the case of a uniform accelerated motion[1].

The fundamental form in this case is

$$ds^2 = (1 + 2\omega x)\,dt^2 - \frac{dx^2}{1 + 2\omega x} - dy^2 - dz^2 \qquad (2)$$
$$\omega = g/c^2,$$

where g is the acceleration.

The corresponding transformations are

$$x_0 = \frac{(1 + 2\omega x)^{1/2}}{\omega} \cosh \omega t - \frac{1}{\omega};$$
$$t_0 = \frac{(1 + 2\omega x)^{1/2}}{\omega} \sinh \omega t; \qquad (3)$$

whence

$$\frac{\partial x_0}{\partial x} = (1 + 2\omega x)^{-1/2} \cosh \omega t,$$
$$\frac{\partial x_0}{\partial t} = (1 + 2\omega x)^{1/2} \sinh \omega t,$$
$$\frac{\partial t_0}{\partial x} = (1 + 2\omega x)^{-1/2} \sinh \omega t, \qquad (4)$$
$$\frac{\partial t_0}{\partial t} = (1 + 2\omega x)^{1/2} \cosh \omega t,$$

where $x_0 \ldots$ refers to Galilean space.

As can be seen from (3), the part

$$\left(x_0 + \frac{1}{\omega}\right)^2 - t_0^2 \leqslant 0$$

of Galilean space has no corresponding points in the curved space; the boundary is at $x = -1/2\omega$, and the transformations (4) become infinite on the boundary.

A phenomenon which can serve as a test is the rate of radiation of an accelerated electron; it is equal to the Poynting's flux:

$$\int p_n dS. \qquad (5)$$

In the case of a uniform rectilinear motion, (5) vanishes, and there is no radiation.

To find the radiation in accelerated motion, (5) is transformed to the new co-ordinates (3); the flux corresponding to the transformed tensor does not vanish; it leads to the correct value of the rate of radiation of an electron moving with acceleration g.

It is important to notice that the flow of energy takes place only through the singular plane $x = -1/2\omega$.

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A Statistical Criterion to Determine the Group to which an Individual Belongs

In a previous note[1], I have discussed the logical problems involved in the classification of an individual into one of two groups to which he can possibly belong. Some observations were the same as those given by Welch[2] in an earlier note. The solution derived above was identical with the discriminant function proposed by Fisher for this purpose. The corresponding problem when the individual has to be specified as a member of one out of many groups to which he can possibly belong does not appear to have been tackled. The following solution, which comes out as an obvious extension of the discriminant function analysis, has been derived so as to satisfy a logical set of requirements.

Let $\pi_1, \ldots, \pi_k$ be k populations with the corresponding probability densities $f_1, \ldots, f_k$, each containing p measurements on an individual as variables. If an individual can be represented by an ordered set of p measurements or a point in a space of p dimensions, then the problem requires a division of the space into mutually exclusive regions $R_1, \ldots, R_k$, with the rule of procedure of assigning an individual to π_i if he belongs to R_i.

Let $P(I \subset R_i \mid \pi_i) = \beta_i$ denote the probability of an individual I of π_i falling in R_i. If the above rule is applied to a collection of individuals in which the proportion of those belonging to π_i is p_i then the proportion of misclassifications will be $1 - (p_1\beta_1 + \ldots + p_k\beta_k)$. If this has to be made a minimum, then using the calculus of variations one finds that the region R_1 is to be chosen as $p_1f_1 \geqslant p_2f_2$, $p_1f_1 \geqslant p_3f_3$, $\ldots$, $p_1f_1 \geqslant p_kf_k$, and similarly the regions $R_2, \ldots, R_k$; it is easy to see that the regions so constructed are mutually exclusive and they cover the whole p-dimensional space.

In case the p's are not known and the individual is equally likely to have arisen from any group, the solution is obtained by replacing the p's by unity in the previous one. It can be seen that in some problems the p's may be replaced by pre-assigned quantities depending on the risks associated with the misclassification of individuals belonging to various populations.

As an application of this, we may consider three multivariate normal populations with the identical dispersion matrix (α_{ij}) and its inverse (α^{ij}). If m_{ij} represents the mean of the i-th character in the j-th population and $x_1, \ldots, x_p$ are the measurements on an individual, then the following functions can be constructed.

$$L_1 = 2\Sigma(\alpha^{i1}m_{11} + \alpha^{i2}m_{21} + \ldots + \alpha^{ip}m_{p1})x_i - \Sigma\Sigma\,\alpha^{ij}m_{i1}m_{j1}$$

$$L_2 = 2\Sigma(\alpha^{i1}m_{12} + \alpha^{i2}m_{22} + \ldots + \alpha^{ip}m_{p2})x_i - \Sigma\Sigma\,\alpha^{ij}m_{i2}m_{j2}$$

$$L_3 = 2\Sigma(\alpha^{i1}m_{13} + \alpha^{i2}m_{23} + \ldots + \alpha^{ip}m_{p3})x_i - \Sigma\Sigma\,\alpha^{ij}m_{i3}m_{j3}.$$

The individual is assigned to π_1 if $L_1 \not< L_2$, $L_1 \not< L_3$; to π_2 if $L_2 \not< L_3$, $L_2 \not< L_1$; and to π_3 if $L_3 \not< L_1$, $L_3 \not< L_2$. The procedure is similar when more than three populations are involved. If in the above problem the dispersion matrices are not identical, the functions corresponding to the L's will be quadratic in the variables $x_1, \ldots, x_p$.

In some problems it may be necessary to assert with some degree of confidence that an observed individual has arisen from a particular population. In such a case each of the regions R_i may be divided into two mutually exclusive regions R'_i and D_i, so that if the individual falls in R'_i he is taken as belonging to π_i, and if in D_i he is provisionally accepted as belonging to π_i. This latter class may be denoted by π_i ?. The region R'_i may be chosen such that $P(I \subset R'_i \mid \pi_i)$ is maximum subject to the condition that the probability of an individual from any population other than π_i falling in R'_i is $\not>$ than a conventionally chosen value (0·05). Applying the calculus of variations one finds that the region R'_i is given by $f_i \geqslant a_1f_1 + \ldots + a_kf_k$, where $a_1, \ldots, a_k$ are chosen such that $P(I \subset R'_i \mid \pi_i)$ is maximum subject to the condition $P(I \subset R'_i \mid \pi_j)$ for any $j \neq i$ is $\not>$ than 0·05. If in some situations the values of $P(I \subset R'_i \mid \pi_j)$ are specified in advance, then the a's can be chosen to satisfy these conditions.

It results in a certain amount of simplification if the region R'_i is defined as $f_i \geqslant A_1 f_1$, $f_i \geqslant A_2 f_2$, . . ., $f_i \geqslant A_k f_k$, where the A's are suitably chosen. This, however, differs from the best region obtained above. The comparative advantages of these regions and their use in the statistical theory of choice of one out of many alternatives will be discussed in a paper to be published elsewhere.

I wish to thank Prof. R. A. Fisher for his valuable advice in the preparation of this note.

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Aug. 12.

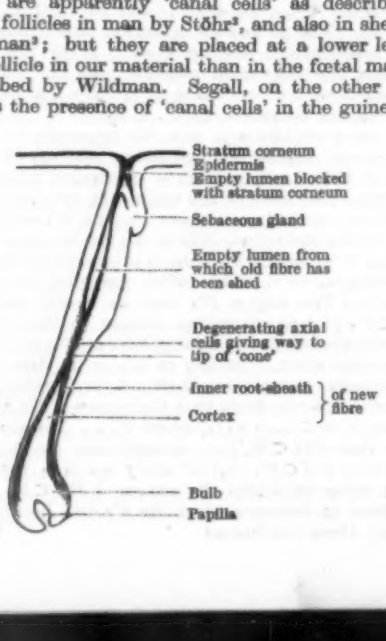
[1] *Nature*, **159**, 30 (1947).
[2] *Biometrika*, **31**, 218 (1939).

Replacement of Fibres in Sheep

Empty follicles, from which the fibres have apparently been shed, have been observed in skin samples from several breeds of sheep of various ages from one month to five years old, namely, Romney, Leicester and Blackface breeds. These skin samples were fixed either in formol saline or in Zenker and stained by a special combination of safranin, alum-carmine and picro-indigocarmine, details of which will be published elsewhere.

Examination of such follicles in horizontal and vertical serial sections has revealed the frequent occurrence of a type of shedding in which the old fibre is lost from the follicle when the new fibre is in the very early stages of its development, so that there is no possibility of the new fibre either growing alongside the old one or mechanically forcing it out, as described in other mammals by Segall[1] and others. In a few instances, a shed 'club-rooted' fibre was observed lying loosely in the distal part of the follicle some distance above the new fibre cone.

A second interesting feature is the occurrence in the follicle, immediately above the level of the tip of the new fibre cone, of an axis of cells histologically corresponding to the granular layer of the epidermis; these are apparently 'canal cells' as described in fœtal follicles in man by Stöhr[2], and also in sheep by Wildman[3]; but they are placed at a lower level in the follicle in our material than in the fœtal material described by Wildman. Segall, on the other hand, denies the presence of 'canal cells' in the guinea pig.



The accompanying diagram illustrates some details of the shedding process just described.

Further work is in progress, in order to determine the frequency and causes of this and other types of fibre-shedding in sheep, and to elucidate the cytological details of shedding and replacement of fibres. Fœtal material prepared in the above way will also be examined for the presence of an axis of granular layer cells in the developing follicles.

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New Divisions of Vascular Plants

A widely used classification of vascular plants has recognized four divisions: Psilopsida, Lycopsida, Sphenopsida and Pteropsida[1]. The first three have been erected in the course of time out of Jeffrey's[2,3,5,16] original Lycopsida. The fourth has not been changed from Jeffrey's[2,4,5,16] original Pteropsida, and is further subdivided into Filicineæ (ferns) and Spermatophyta (seed plants)—both very large groups. The three divisions and these two subdivisions make five groups of plants widely recognized as distinct groups, though accorded a variety of taxonomic ranks.

Having to teach over the whole range of botany for some years, I have had problems of taxonomy at the higher levels forced on my attention, and for some time have felt a difficulty in expounding the Pteropsida as a coherent group corresponding to the Psilopsida, Lycopsida and Sphenopsida. Our present-day clearer knowledge of meristematic activity at apices, and in the origin of leaf primordia and branch primordia, together with other considerations, has led me to propose that the division Pteropsida be replaced by two divisions, the Filicopsida (ferns) and Spermatopsida (seed plants).

These two divisions may be differentiated as follows.

Filicopsida (the ferns, formerly Filicineæ—see Eames[1]—or Filicales—see Scott[6] and Bower[7]): (*a*) One superficial apical cell or 1–4 uniform superficial apical cells as initiators of structure. (*b*) Primary branching at the apex of the shoot infrequent, prominently dichotomous[8] and terminal. (*c*) Leaves arise from one or a very few superficial cells and develop superficial apical cells. (*d*) Sporangia of only epidermal origin. (*e*) Dispersed as spores.

Spermatopsida (the seed plants, formerly Spermatophyta—see Rendle[9] and Eames[1]—or Spermophyta—see Scott[6]): (*a*) Differentiated, massive meristem, several layers deep, as initiator of structure. (*b*) Primary branching at the apex of the shoot frequent, lateral and axillary to the leaves. (*c*) Leaves arise by combined activity of a zone of cells several layers deep, and develop a meristem which, if apical, is massive and differentiated. (*d*) Sporangia of essentially hypodermal origin. (*e*) Dispersed as seeds.

Just[8] has put forward a timely plea for observance of the Rules of Botanical Nomenclature in connexion with the major groups of plants. There are great difficulties here as the relevant data are much more complex than for the minor groupings—species,

genus, etc. In the above proposal the name Pteropsida was dropped because, among other reasons, *Pteridium aquilinum* appears in Jeffrey's papers[2,4,5] to have no greater claim than many other species, including angiosperms and gymnosperms, to be the type species at the base of a hierarchy of names. I have not attempted to formulate descriptions of the new divisions in set terms, because, though the evidence points clearly to them as good divisions, there is yet more data to be produced anatomically (cf. Dormer[10]), experimentally (cf. Wardlaw[11] and Ball[12]) and bibliographically before we are in a position to do this with assurance of an approach to finality.

This proposal was put before the Botanical Sciences Section of the Sixth Science Congress of the Royal Society of New Zealand, on May 20 of this year. The full statement of the reasons for the proposed change in status and for the choice of names for the new divisions will appear in the published report of the Congress[13]. The present communication is to give a wide and early notice so that those interested may be prepared to receive the proposals with considered criticism.

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June 18.

* Cases of divergence from this are held within the division by other features.

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[11] Wardlaw, C. W., *Nature*, **153**, 377 (1944); **153**, 588 (1944); **156**, 39 (1945).
[12] Ball, E., *Amer. J. Bot.*, **33**, 301 (1946); see also *Nature*, **158**, 763 (1946).
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Aphid Vectors of European Raspberry Viruses

THE failure in vigour and productivity of cultivated raspberries during the last decade in England, and more especially in the concentrated raspberry-growing districts of Scotland, has been due mainly to the spread and cumulative effect of a number of virus diseases. This has been amply demonstrated by the work of Harris[1,2] and our own unpublished work. A precise determination of the viruses concerned and of their interrelations and the development of remedial measures have, however, been severely handicapped by the absence hitherto of information on the natural vectors of the viruses concerned.

Insect transmission of the European raspberry viruses has long been suspected on the basis of evidence from combined field studies of insect fauna and disease spread[3]. Confirmation of these suspicions, provided by data from a series of experiments begun by one of us (C. H. C.) in 1944, is the reason for publishing this note.

The only aphid species of general occurrence on raspberries in Scotland are *Amphorophora rubi* Kalt. and *Aphis idæi* V.d.G. Exploratory experiments carried out in 1944 and 1945 demonstrated that both these species could act as vectors of viruses causing two distinct types of mosaic disease, whereas all attempts to effect transmission by means of jassid and thrips species proved negative. A series of more critical experiments carried out in 1946 have confirmed these findings and provided the data set out in the accompanying table.

Populations of aphids were allowed to feed, for the time intervals stated, on entire plants or, in the case of Series *A*, on detached leaves, of an apparently healthy stock of Lloyd George known to be carrying at least the Mosaic 2 virus or viruses of Harris[2]. The cultures were maintained under muslin sleeve cages from which large numbers of aphids were transferred to each of ten virus-free plants of the indicator variety Norfolk Giant similarly caged. The aphids were allowed to feed on these healthy plants for varying periods, up to 14 days, before being destroyed by fumigation.

Series	Infection feeding time on Lloyd George	Aphid spp.	
		A. rubi	*A. idæi*
A	12 hours	0/10*	0/10
B	3 days	1/10	1/10
C	7 days	2/10	1/10
D	14 days	2/10	2/10
E	21 days	0/10	2/10

* Numerators show numbers of plants infected; denominators show number of plants colonized with aphids.

The experiments were, of necessity, performed in non-insect-proof glasshouses, but, whereas symptoms of mosaic appeared in the indicator plants of Series *C* and *E* 24 days after the date of transfer, no such symptoms developed either on the twenty control plants or on the stock plants upon which the aphid cultures had originally been reared.

With one exception, Norfolk Giant plants on which *Amphorophora rubi* had fed developed symptoms only of Mosaic 2; while the six affected plants in the set of fifty to which *Aphis idæi* was transferred all developed symptoms of a distinct and hitherto undescribed disease provisionally named 'curly dwarf' (Harris and Prentice *in litt.*). The exceptional plant in the *A. rubi* series also developed curly dwarf. The presence, in the Lloyd George infector stock, of the viruses causing these diseases has since been confirmed by grafting to indicator hosts.

The results suggest that both aphid species require feeding periods longer than twelve hours to pick up the viruses causing these distinct symptoms, and also that at least *Aphis idæi* shows a marked degree of specificity in the viruses transmitted. The design of the experiments does not permit of any further deductions on the relations between the aphid vectors and the viruses they transmit.

So far, transmission has been achieved with difficulty; very large numbers of aphids have been employed except in the case of a subsidiary experiment using seedling plants raised from a Norfolk Giant × St. Walfried cross, where transmission of Mosaic 2 by *Amphorophora rubi* was effected by 25–50 aphids per plant. This finding is, however, in conformity with the slow rate of spread of mosaic diseases under field conditions.

A fuller account of these and cognate investigations will be published at a later date. The evidence here

set out does, however, permit the conclusion that the common raspberry aphids, *Amphorophora rubi* Kalt. and *Aphis idæi* V.d.G. are capable of acting as vectors of certain raspberry viruses under Scottish conditions.

The investigation, of which this work forms a part, is financed by a grant from the Agricultural Research Council, to which our acknowledgments are therefore due.

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[1] Harris, R. V., *J. Pom. and Hort. Sci.*, 11, 237 (1933).
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Optimum pH and Temperature, and Energy of Activation of the Transamination between Glutamic Acid and Pyruvic Acid

In a previous paper[1] I stated that the process:

$$\text{glutamic acid} + \text{pyruvic acid} \underset{}{\overset{a}{\rightleftharpoons}} \alpha\text{-ketoglutaric acid} + \text{alanine} \quad . \quad . \quad . \quad . \quad . \quad (1)$$

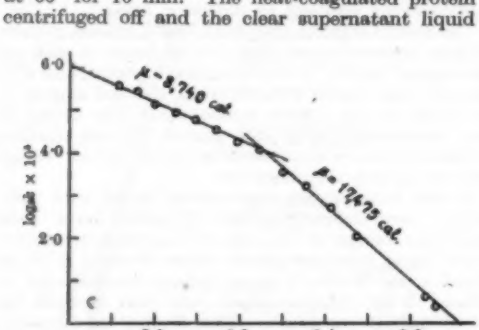
reaches an equilibrium through a first-order reaction according to the equation:

$$\log_e (1 - \alpha/\alpha_e) = -kt.$$

In this, k is the velocity coefficient, t the time measured in seconds, α the degree of reaction at the time t, and α_e at the time $t = \infty$, when the equilibrium has been attained. In the temperature interval 15°–70° and at *p*H 7·5, $\alpha_e = 0{\cdot}60$ for reaction (1*a*) and $\alpha_e = 0{\cdot}40$ for (1*b*).

Using k as a measure of the strength of the enzyme (alanine–glutamic transaminase), it is possible to determine in an absolutely unambiguous way the relation between enzyme activity and *p*H or temperature.

The enzyme was prepared by extraction of minced ox hearts with 1/15 *M* phosphate buffer (*p*H 7·5). The liquid is pressed through a linen cloth and half saturated with ammonium sulphate. The precipitate containing the enzyme is filtered off, suspended in water and dialysed in a 'Cellophane' tube against running tap water. The undissolved residuum is centrifuged off and discarded. The solution is heated at 60° for 10 min. The heat-coagulated protein is centrifuged off and the clear supernatant liquid is used in what follows. The determination of k is carried out as previously described[1]. The concentration of substrate in the reaction mixture (enzyme + substrate + buffer) is 0·0167 *M* with regard to amino- and keto-acids.



An Arrhenius plot of the effects of temperature upon the glutamic–alanine transaminase system. The energies of activation are calculated from the slope of the lines

Using k as a measure of the enzyme strength, it appears that the reaction has a maximum of velocity at *p*H 7·5 in accordance with Kritzmann's result[2]. The velocity is very sensitive to changes in *p*H; altering *p*H from 7 to 7·5 increases k about threefold. In a similar manner the optimum temperature is found to be 75° C. In order to decide whether the enzyme reaction follows the Arrhenius equation, $\log_e k \times 10^3$ is plotted against the reciprocal absolute temperature ($1/T \times 10^3$) as shown in the accompanying graph. A sharp break in the relationship occurs at 34°. It is apparent that the reaction follows the Arrhenius equation accurately from 0° to 34° with an energy of activation of 17,475 cal., and from 34° to 70° with an energy of activation of 8,740 cal. Such a shift at a critical temperature has been reported previously with regard to other enzyme systems[3].

The energy of activation and Q_{10} for the alanine-glutamic transaminase system as reported by me earlier[1] is no longer relevant, as the temperature interval in which the two constants are computed (25–35°) includes the critical temperature.

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May 18.

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Visual Cells of the Guinea Pig

O'Day has pointed out[1] that his histological preparations provide definite evidence for the presence of cones in the retina of the guinea pig. I welcome this statement, although I have myself, as he indicated, relied on authors who have denied it. Occasionally one finds evidence for red modulators in the eye of the guinea pig (see, for example, Fig. 140, p. 281, of my recent summary[2]). Such modulators, I maintain, should be ascribed to cones if the histological differentiation of the cells into rods and cones is going to mean anything at all to retinal physiology. There are more of them in the eye of the rat. Since, however, some histologists deny the presence of cones in the eye of the rat (see ref. 2), and others refuse to accept them in the guinea pig, the physiologist must try to stand on his own feet.

I have suggested[2] that the red modulators in the eye of the rat are due to cones. But cones cannot be as important in the eyes of the guinea pig and the rat as in the retina of the cat. The latter has a very much greater number of the on/off-elements typical for cones (80 per cent); at least 36 per cent of the elements show a complete Purkinje shift with light adaptation. I have never found such Purkinje shifts in the eyes of rats and guinea pigs[2].

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Nov. 12.

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ROYAL SOCIETY MEDAL AWARDS, 1947

THE following is the substance of the remarks made by Sir Robert Robinson, president of the Royal Society, in presenting the medal awards for 1947 at the anniversary meeting on December 1.

Copley Medal

The Copley Medal is awarded to Emeritus Prof. G. H. Hardy in recognition of his distinguished contributions to mathematics [died December 1].

For many years G. H. Hardy has occupied an outstanding position among mathematicians in Great Britain, while his eminent services and original work have also been very widely recognized in other countries. In his memoirs and papers published with collaborators, especially J. E. Littlewood, are to be found the origins of the major developments of 'classical analysis' throughout the world in the years 1910–35.

Among the most influential and original of his works are those dealing with the Tauberian theorem for Cesáro summability (1910); the proof that the Riemann zeta-function has an infinity of zeros on the critical line (1914); the asymptotic formula for the number of partitions of an integer (with Ramanujan, 1918); the papers on Waring's problem and Goldbach's problem (with Littlewood, 1920, 1922); the paper in *Acta Mathematica* on Fourier series (with Littlewood, 1930). He has made important contributions to lattice-point theory, to the theory of integral equations, and (with Littlewood) to the theory of Diophantine approximation.

Lying in widely separated domains of analysis, all these papers contain fundamentally novel ideas which were the starting-points for new significant developments by Hardy and others. For example, a part of the distinguished work of Vinogradoff may justly be said to derive from that of Hardy. His influence has been exerted, not only by his publication of original work, but also through a long succession of pupils, many of whom are now well-known mathematicians. At a time when the vigorous treatment of analysis in university courses had still to win general acceptance, Hardy's enthusiastic advocacy and his inspiring lectures had a decisive effect. In addition, the appearance of his highly individual text-book "Pure Mathematics", helped to demolish finally the barriers between the British and Continental schools of mathematics.

It is impossible to characterize in a few sentences the achievement, so varied, and so abstruse, of the Copley Medallist for 1947, but in very ordinary words it may be said that Hardy saw clearly what were the most important tasks and problems lying before mathematicians; he had good judgment in selecting those which seemed ripe for attack, and he displayed the greatest skill and energy in their solution.

Royal Medals

A Royal Medal is awarded to Prof. C. N. Hinshelwood, for his outstanding researches in chemical kinetics.

Prof. Hinshelwood has brought a characteristic lucidity of mind and directness of approach to bear on the investigation of many classical problems presented by the course of chemical change. He has clarified these subjects to an extent which seems remarkable to those who recall the mystery which enshrouded them only a few years ago.

The acute suggestion of Lord Cherwell relating to the consequences flowing from the relative rates of formation and decomposition of an intermediate additive complex was taken up and extended by Hinshelwood. He predicted that on the basis of this theory certain apparently monomolecular reactions should follow a bimolecular law at low pressures. One example of the justification of this prophecy was found in the decomposition of acetaldehyde. This experimental verification of the hypothesis of intermediate complexes of definite life, and the new light shed on the mechanism of activation of molecules, are pillars of modern chemical kinetics. Hinshelwood has enlarged our knowledge of this subject by many other researches of great importance including those on the synthesis of water, a classical problem of seeming simplicity and real complexity, and those on the conditions of 'chain' reactions. His ingenious experimental methods, though characterized by a lack of unnecessary elaborations, have nevertheless always been able to provide accurate results.

It was a very original conception to apply the principles and methods of chemical kinetics to the growth of bacteria, and Hinshelwood has already made noteworthy progress in this field. The outcome has been to provide a new and more delicate assessment of the presence and activity of factors that influence growth at all stages under defined conditions.

During the War he carried out important researches on the adsorption of gases by charcoal, and on the preparation of suitable adsorbents for different purposes, ranging from gas-masks to the production of penicillin.

The brilliant exposition of chemical topics contained in Prof. Hinshelwood's books places contemporary chemists and students still further in his debt. His memorable addresses on the wider implications of chemistry made as president of the Chemical Society and on the occasion of the celebration of its centenary were generally acclaimed. Possessing enviable linguistic attainments, he has frequently been an 'ambassador of British science'. Recognizing these achievements we wish to honour Prof. Hinshelwood above all for his pioneering work in the laboratory and in the study, which has thrown so much light on the most fundamental processes of chemistry, the mode of interaction of molecules.

A Royal Medal is awarded to Dr. F. M. Burnet for his distinguished contributions to our knowledge of the viruses.

Dr. Burnet, director of the Walter and Eliza Hall Institute, at Melbourne, has made a series of extremely significant investigations of bacteriophages and viruses since 1925. In twenty-seven papers on the first topic he has made greater advances than anyone apart from d'Herelle. He has elucidated the phenomenon of lysogenesis or 'carrying' of a bacteriophage, active against other bacteria, by an organism which is itself apparently unaffected. He has shown how study, partly on a biochemical basis, of the range of activity of 'phages against various bacteria

can be used to classify not only the 'phages but also the bacteria themselves. Other investigations have made an important contribution to our present ideas as to what bacteriophages are.

Since 1933 he has studied many viruses pathogenic for vertebrates. He has shown how psittacosis is endemic in wild Australian parrots, and has thrown light on the epidemiology of herpes and poliomyelitis. To modern workers he is best known for his development of several techniques for cultivating viruses in living chick embryos, and their application in immunological and other studies of viruses, especially influenza. He has written monographs on the use of chick embryos in virus research, on immunity to viruses, on influenza and on the nature of antibodies.

At present he is examining the agglutination of mammalian and avian red blood cells by a number of viruses and virus-products, and is thus throwing fresh light on the reactions taking place between viruses and the surfaces of susceptible cells. He has found that an enzyme produced by cholera vibrios has an action on blood cells which is quite similar to that of influenza viruses, and is capable of blocking the union between virus and susceptible cell. This discovery indicates one line of approach to the problem of the chemotherapy or chemoprophylaxis of virus infections.

Burnet has been active in many other fields; he has studied staphylococcal toxins and he was the first to make a formolized staphylococcal toxoid. He has demonstrated that a rickettsia is the cause of Australian *Q*-fever.

While his experimental studies have demanded close attention to detail, certain continuous threads have connected his interests. The breadth of his outlook and his philosophic attitude of mind are well exemplified in his fascinating book "Biological Aspects of Infectious Diseases" and in the more recent publication "Viruses as Organisms".

Davy Medal

The Davy Medal is awarded to Prof. Linus Pauling in recognition of his distinguished researches on molecular structure.

The unusual breadth of Prof. Pauling's scientific knowledge, his mastery of physics and mathematics in addition to chemistry, made him peculiarly fitted to apply quantum mechanics to problems of chemical valency bonds. In him, theoretical acumen and penetrating insight are associated with experimental skill of the highest order, and thus his theories were often tested after the devising of new physical techniques. This combination of theoretical and practical attainments is very remarkable at such a level in both aspects.

As a natural consequence of his catholic interests, Pauling's work has covered a very wide range of chemical structural problems. He has devoted much attention to line spectra and many other physical topics; but his most individual achievements are in the advance of molecular structure theory. In elucidating the fundamental structure of simple organic compounds he developed the method of localized pairs (atomic orbitals) to provide a theoretical treatment of the valency conditions of such molecules. By this introduction of orbital hybridization he gave the first theoretical account of the tetrahedral distribution of the valencies of the saturated carbon atom (1928). This was followed by the introduction of the quantum mechanical concept that the actual state of a molecule such as benzene should be represented as a resonance hybrid of several valency bond structures (1931). The application of this idea and the experimental verification of its structural implications in terms of increased stability and decreased bond distances greatly increased our understanding of aromatic and general chemistry. The calculus of the resonance theory of Pauling was the first to introduce a quantitative treatment of valency problems, and its effect has been felt far beyond the bounds of the experimental material.

In 1939 his extensive work was summarized in a great book "The Nature of the Chemical Bond", which will always be one of the classics of chemistry. Here we find a general classification of stubborn aspects of valency theory along with valuable tables of generalized and correlated data on resonance energy terms, bond distances and angles, and atomic radii.

Proceeding to apply his methods to the study of more complex molecular systems, Pauling has made important contributions to our understanding of the metallic bond; of the structure and mode of denaturation of native proteins; and of the mechanism of the fundamental reactions of immunology, that is, antibody formation, and the antibody–antigen interaction.

Prof. Pauling has earned our gratitude, not only for his personal services, great as those have been, but also because he has been a focus of activity and a constant source of inspiration to other workers.

Buchanan Medal

The Buchanan Medal is awarded to Sir Edward Mellanby for his services to medical science and in recognition of his outstanding researches on dietary factors.

The Buchanan Medal is awarded every five years in respect of distinguished services to the science or practice of hygiene in the direction either of original research, or of professional, administrative, or constructive work, without limit of sex or nationality. In each of these respects the award to Sir Edward Mellanby is surely one of the most appropriate that could be made. For some thirteen years he has devoted himself to the service of medical science and the national organisation of medical research. His personal research work, which has been continued right up to the present time, has been concerned mainly with problems of nutrition, and has had important results in the relation of diet to the public health.

Sir Edward's two most important contributions have been on the effects of deficiency of vitamin D and of vitamin A in the diet. He first showed that rickets was unquestionably due to the lack of a fat-soluble vitamin, since known as vitamin D, and he also demonstrated that other factors, dietary and general, such as lack of exercise, contributed to aggravate the condition. Quite recently he has shown that lack of vitamin A, in addition to the already recognized effects on general health, is capable of producing profound neurological disorders, owing to the mechanical effect of abnormal growth of bones around the foramina through which nerves leave the central nervous system. The knowledge which has been made available as a result of his investigations has played an important part in the feeding of the nation on scientific lines, in war, and in peace-time.

The study which he made of the effects of lack of iodine has thrown much light on the various forms

of goitre, and especially on the hyperplastic and colloid forms: the former he showed to be caused by iodine deficiency, particularly in young animals, or in ante-natal states, while the latter is produced by the belated admission of iodine to such sufferers from the hyperplastic condition. The knowledge has been of value in connexion with the lack of iodine in the water and soil of some districts.

Mellanby's researches on the physiological effects of alcohol have also provided valuable knowledge concerning the effects of this substance as a constituent of the diet.

His most recent contribution has been to show that bread which is made from flour bleached by the 'Agene' process, that is, with nitrogen trichloride, can cause the condition in dogs known as canine hysteria.

As the secretary of the Medical Research Council, Sir Edward has proved himself a wise, strong and withal a helpful administrator.

Hughes Medal

The Hughes Medal is awarded to Prof. J. F. Joliot in recognition of his outstanding researches in nuclear chemistry and physics.

Prof. Joliot, director of the Nuclear Chemistry Laboratory of the Collège de France, was early concerned with investigations leading to the discovery of the neutron and with subsequent work on that particle. In 1932 he found that the very penetrating radiation emitted when beryllium is bombarded with alpha-particles was able to eject protons from hydrogenous material upon which it fell. This observation was followed up by Chadwick, who was able to show that the radiation consisted of the neutrons which he and Rutherford had sought for years.

In 1934 Joliot made a discovery of the utmost importance. He found that aluminium and other light-atom substances were rendered radioactive by bombarding them with alpha-particles. He showed that these radioactive products emitted positive or negative electrons and gamma-rays. By chemical methods he proved that the radioactivity produced was due to the formation of unstable isotopes of neighbouring elements; for example, in the case of aluminium, the active substance produced was an isotope of phosphorus. It was soon shown that the production of these artificially radioactive isotopes was possible by bombardment with other types of particle and that practically all the elements could be prepared in radioactive form. In this way Joliot founded an important development of modern 'tracer' technique and opened up a field of investigation of immense importance to physical, chemical, and biological science.

In 1939 Joliot and his co-workers observed that in the process of fission of uranium several neutrons are emitted. This important observation indicated the possibility of a chain process in uranium, and Joliot at once endeavoured to produce such a self-propagating reaction. With Halban and Kowarski he showed, in 1940, that if the fission neutrons were slowed down in heavy water a chain-reacting system could be produced. The practical success of the heavy-water 'piles' in the United States of America and in Canada is the outcome of these pioneering discoveries in the application of atomic energy.

In a great part of his work, Prof. Joliot has been closely associated with his wife, Prof. Irène Joliot-Curie.

SYNTHESIS OF PHOSPHOLIPIDS IN THE FŒTUS

By G. POPJÁK

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WHETHER fœtal lipids are derived primarily from the preformed maternal substances by placental transmission, or from synthesis within the fœtus, cannot yet be answered satisfactorily. Up to now, most investigators have been concerned with the placental transmission of fatty (and other) substances, and very little has been done to explore the possibility of synthesis of these compounds by the fœtus. Nielson[1] studied the permeability of the rat placenta to phospholipids with the aid of P^{32} and found that after the injection of the mother with inorganic phosphate, labelled with P^{32}, radioactive phospholipids could be isolated from the fœtuses within 2 hr. after the injection. When, on the other hand, an emulsion of phospholipids labelled with P^{32} was injected intravenously to the mother, the appearance of radioactive phospholipids in the fœtuses was very much delayed, and even then only small amounts were found. Nielson, therefore, concluded that the placenta does not transmit phospholipids and that these substances are readily synthesized within the fœtus. In my experience, when an emulsion of phospholipids is injected intravenously, so long as any of the excess phospholipid remains in the circulation, it always stays in the form of an emulsion. The only conclusion, therefore, that can be drawn from Nielson's work is that the placenta does not transmit emulsions of phospholipids; whether this is also true for the plasma phospholipids in the physiological state of dispersion remains an open question. In order to follow the experimental design of Nielson in the investigation of the sources of fœtal phospholipids, the mothers should be transfused with plasma containing labelled phospholipids. Up to now, the supplies of P^{32} in Great Britain have been small, and therefore this experiment, requiring relatively large amounts of the isotope, is not practicable.

There is, however, another possible way of attacking this problem. After the injection of a suitable dose of P^{32} in an inorganic form, the plasma phospholipids become labelled with this isotope. If fœtal phospholipids are derived from the preformed maternal substances only, then the radioactivity of fœtal phospholipids should never exceed the activity of the maternal plasma phospholipids. If, on the other hand, a rapid synthesis takes place within the fœtus, and if the transfer of inorganic phosphate from the mother to the fœtus is sufficiently rapid, then there might conceivably be a time when the activity of the fœtal phospholipids is greater than the activity of the maternal plasma phospholipids.

Pregnant rats, guinea pigs and rabbits were injected subcutaneously or intravenously with disodium hydrogen phosphate labelled with P^{32}. After varying intervals, the phospholipids were isolated from the maternal plasma, maternal liver, fœtal liver, fœtal carcass and viscera, fœtal placenta, and whenever possible from the fœtal plasma also, and their radioactivities compared. In several experiments, the inorganic phosphate of the tissues was precipitated as the ammonium-magnesium salt from a trichloracetic acid extract and its radioactivity measured

TABLE 1. RADIOACTIVITY OF TISSUE INORGANIC-P AND OF PHOSPHOLIPID-P RELATIVE TO THAT OF MATERNAL PLASMA PHOSPHOLIPID-P

Rabbit 138: 3·16 kgm., 26th day pregnancy, 4 hr. after intravenous injection of a single dose of P^{32} as Na_2HPO_4

Source	Specific activity in relative units	Activity of liver phospholipid-P as % of activity of tissue inorganic-P
Maternal plasma phospholipid-P	100	—
Maternal liver inorganic-P at the end of experiment	2570	—
Maternal liver phospholipid-P	405	15·76
Fœtal liver inorganic-P at the end of experiment	1098	—
Fœtal liver phospholipid-P	221	20·10
Fœtal placenta phospholipid-P	328	—
Fœtal plasma phospholipid-P	39·6	—
Fœtal carcass (without liver) phospholipid-P	45·3	—

also. The measurements of radioactivity were carried out with a Geiger-Müller counter.

The results were alike in all three species, and because more detailed experiments were carried out with rabbits, results of representative experiments obtained on this animal alone are shown. From Table 1 it is evident that the activity of the phospholipids extracted from the fœtal liver and fœtal placenta was much greater than the activity of the maternal plasma phospholipids 4 hours after the injection of the mother with labelled phosphate. These two fœtal organs, therefore, appear to be sites of phospholipid synthesis. The activity of the fœtal carcass- and plasma-phospholipids, on the other hand, was much less than the activity of the maternal plasma phospholipids; and therefore it cannot definitely be decided from this and similar experiments whether these phospholipids were synthesized within the fœtus or derived from the mother by placental transmission. The low specific activity of the fœtal plasma phospholipids shows that the highly active lipids in the fœtal liver have been synthesized in that organ, and have not been transported from the fœtal placenta.

The observed radioactivity of phospholipids extracted from the tissues, after the injection of labelled phosphate into an animal, depends not only on the rate of synthesis of the lipid, but also on the abundance of the isotope in the inorganic phosphate fraction of the tissues. In the experiment shown in Table 1, the activity of the maternal liver phospholipid phosphorus was 15·76 per cent and that of the fœtal liver phospholipid phosphorus 20·1 per cent of the activity of the inorganic phosphorus in these organs. There are reasons to believe that this difference indicates that the rate of phospholipid synthesis is higher in the fœtal than in the maternal liver, the most active adult organ in this respect.

TABLE 2. RELATIVE SPECIFIC ACTIVITIES OF PLASMA- AND TISSUE-INORGANIC-P AND PHOSPHOLIPID-P IN MOTHER AND FŒTUS

Rabbit 148: 3·5 kgm., 24th day pregnancy. The radioactivity of maternal plasma-inorganic-P was maintained constant (to within ± 10 per cent) for 250 minutes by the repeated subcutaneous injection of P^{32} at 20–30 min. intervals

Source	Specific activity of		Activity of tissue phospholipid-P as % of activity of inorganic-P in the tissues
	Inorganic-P	Phospholipid-P	
Maternal plasma	100	0·945	—
Maternal liver	30·72	2·48	8·07
Fœtal plasma	62·9	—	—
Fœtal liver	20·2	2·64	13·06
Fœtal carcass (without liver)	7·14	0·50	7·02
Fœtal brain	1·85	0·147	7·95
Fœtal placenta	30·65	4·34	14·20

In Table 2, results of a more detailed experiment are shown. The activity of the maternal plasma inorganic phosphorus was maintained constant for 250 min. The figures in this table give further emphasis to what has already been said (compare activities of phospholipids) and show, in addition, that the probable reason for the low activities of fœtal carcass- and brain-phospholipids is that the concentration of the isotope in the inorganic phosphate fraction in these tissues was very low. The activities of the fœtal carcass- and brain-phospholipid phosphorus were 7·02 and 7·95 per cent respectively of the inorganic phosphorus in these tissues; values not much lower than the figure for the maternal liver (8·07 per cent). These figures suggest by themselves that there is synthesis in these tissues also, at a rate comparable with that in the maternal liver.

TABLE 3. RELATIVE ACTIVITIES OF FŒTAL PHOSPHOLIPIDS 3 HR. AND 3 HR. 10 MIN. AFTER INJECTION OF LABELLED Na_2HPO_4 INTO RABBIT FŒTUSES 25 DAYS OLD

Rabbits 151 and 152

Source of phospholipids	Specific activity of phospholipids	
	3 hr. after injection	3 hr. 10 min. after injection
Maternal plasma	Inactive*	Inactive*
Fœtal liver	100	100
Fœtal viscera (intestines, kidneys, lungs and heart)	—	39·1
Fœtal carcass (without liver)	17	—
Fœtal brain	3·34	3·84

* That is, no activity could be detected in phospholipids that could be extracted from 15 ml. of plasma.

That phospholipid synthesis is taking place in all fœtal tissues was proved definitely by experiments in which the fœtuses were injected directly *in utero* with disodium hydrogen phosphate labelled with P^{32}. The mothers were given nembutal (three quarters full anæsthetic dose) and for the actual operation the anæsthesia was deepened with ether; after opening the abdomen, the labelled phosphate was injected with a fine needle through the uterine wall into the back of the fœtus. The abdominal incision was then closed. The experiments lasted 1–3 hr.; results of two are shown in Table 3. The fœtuses suffered no apparent ill-effects either from the injection or from the operation on the mother. By this technique it was possible to obtain high activities in the fœtuses and very low activities in the mother. In one experiment, for example, the inorganic phosphorus in 0·1 ml. of fœtal plasma gave 500 counts/min. and the same volume of maternal plasma, withdrawn at the same time, only 5 counts/min. above background. It is evident from Table 3 that the fœtal tissues examined all synthesize phospholipids. When the activity of the phospholipids in these experiments is expressed as a percentage of the activities of the inorganic phosphorus in the tissues, values are obtained which are comparable with those in experiments of the type illustrated in Table 2. This makes it highly probable that all fœtal phospholipids are synthesized within the fœtus.

The evidence presented, of course, indicates only that the phosphorylating step in phospholipid synthesis takes place in fœtal tissues, and it remains to be seen whether the other steps required in building up whole phospholipid molecules also occur.

[1] Nielson, P. E., *Amer. J. Physiol.*, **135**, 670 (1941–42).

CLASSIFICATION, BREEDING AND PRESERVATION OF THE POTATO

A SYMPOSIUM, at which recent investigations on the classification, breeding and preservation of the potato were discussed, was arranged by the Association of Applied Biologists and held in London on October 3.

The South American potatoes, their classification, affinities and value to the potato breeder were discussed by J. G. Hawkes. It was pointed out that breeders are turning more to the indigenous potatoes of the American continent in their attempts to solve problems of disease resistance and adaptation to new environments. The co-operation of the systematist, the cytologist and the geneticist is needed when dealing with the transference of the useful properties from the wild potatoes to the domestic varieties.

Mention was made of the potato-collecting expeditions in South America and especially of the British Empire Expedition sent out by the Imperial Agricultural Bureaux in 1939. An outline was given of the collection brought back by this latter expedition and the work in progress at the Empire Potato Station at Cambridge. Its use in conjunction with Empire potato breeders was also discussed. The distribution of the wild potatoes and their varied type of habitat indicate their possible use in breeding new varieties suited to climates where the potato of commerce will not at present grow.

An outline followed of the method of classification of the wild species into groups, and the valuable economic characters to be found among them. Resistance to blight, frost, viruses and Colorado beetle, together with a form of immunity to potato root eelworm, are to be found among the wild species. Some cultivated potato species are frost-resistant; others possess a very short dormancy and ability to grow at higher temperatures; others, again, are promising in respect of vitamin C and protein contents.

Many of the valuable characters are to be found in potatoes only distantly related to the cultivated varieties of Europe. Studies on chromosome numbers and on the 'crossability' of the various species are giving more exact information on their relationships and helping in the transference of the valuable disease resistance from the wild potatoes into our domestic varieties.

W. Black dealt with blight in potato breeding. Potato seedlings bred from the immune wild species *Solanum demissum* have been tested for resistance to the common strain of blight, *A*, and two new strains, *B* and *C*. Although *B* and *C* are more virulent than *A*, they differ qualitatively from each other. A fourth strain, *D*, appears to be slightly less virulent than *C* and to differ from it quantitatively. The fungus is considered to exhibit plasticity and it is thought that its virulence can be built up or modified by the degree of resistance of the host plants on which it is grown.

Studies on the inheritance of resistance indicate that, with the *A*, *B* and *C* strains, blight resistance behaves as a dominant, appearing to be controlled by four major genes, *Ra*, *Rb*, *Rc* and R_2, conferring immunity from strain *A*, *B*, *C* and all three respectively. It is also considered that minor genes may be present which act as modifiers in the resistant varieties and determine the degree of susceptibility in the susceptible varieties. In genetical studies the ratios obtained always show an excess of recessives. This is thought to be due either to chromosome homologies leading to multivalent production, or more probably to the presence of incompatibility factors contributed from the wild parent.

Tests were described for ascertaining the genetical constitution with regard to blight immunity in parent varieties, and evidence was presented that suggested an increase in the virulence of the *B* strain of blight.

In the afternoon session, A. R. Wilson spoke on methods of potato storage in North America, basing his remarks on information gained during a tour under the auspices of the Agricultural Research Council in consultation with the Department for Scientific and Industrial Research and the National Farmers' Union.

Various types of storage building were described, ranging from an ordinary farm basement to a refrigerated and air-conditioned store built specially for the purpose. Partially or completely sunk stores, depending for their heat insulation chiefly on the soil banking around them, are capable of several modifications. Some are of the deep bin type with bins 18–25 ft. deep—to be found chiefly in the colder areas—whereas others are of the shallow (8–12 ft.) bin type found in the warmer areas.

Surface stores, usually of the shallow bin type, are heavily insulated, especially on the roof, to prevent sudden fluctuations of temperature and water condensation with consequent dripping on to the tubers. Various types of bins with different methods of partitioning and detachable front boards for unloading were detailed.

Ventilation and air circulation seem to be very variable in these stores, and are either of the gravity or of the forced-draught type, with the air circulating through the potatoes or passing in the floor, back and sides of the bins—the so-called 'shell' type. On the evidence available, it would appear that the shell type is the slower though more thorough method of cooling. Methods of bulk transport and of temperature control were treated also. Permanent storage accommodation has a future in Great Britain, but the American methods need careful trial here before they are adopted.

A survey of Scottish seed tuber problems was given by C. E. Foister, dealing chiefly with the methods used in attempting to reduce tuber diseases. Mention was made of the certification scheme, which distinguishes three grades for freedom from virus and trueness to type. A registration scheme is also in force to stimulate the production of varieties immune or resistant to disease. Stress was laid on methods of handling potatoes; it is thought that most farmers pay insufficient attention to dressing out diseases and abnormalities in the tubers before dispatch.

The potato work at the Seed Testing Station at Corstorphine was outlined, and the tests for blight resistance on seedlings raised by private breeders were mentioned. It is believed that there is approximately a 75 per cent correlation between foliage and tuber resistance to blight. The co-operative scheme of dry-rot investigations was also mentioned. Since there are no immune varieties at present known, it is hoped that resistance to dry-rot may be found among the South American potatoes in the Empire Potato Collection. Similarly, no varieties immune to skin spot or to scab are known in Britain, and here again the Empire Potato Collection may prove of value.

Mention was made also of black-leg, blind tuber, and a possible outbreak of potato stem eelworm in Scotland this year.

A. E. W. Boyd described some recent results of dry-rot research, indicating the very severe losses in the variety Doon Star with this disease, and the enormous decrease in the acreage grown during the last few years. It was pointed out that dry-rot is caused by the wound parasite *Fusarium caruleum*, and that the degree of infection is directly proportional to the percentage of wounding. The parasite can also enter through lesions of powdery scab. Rough handling of the potato bags and riddling of the tubers has a very marked effect in increasing the incidence of the disease, and road transport also increases infection with previously riddled tubers.

Methods of control were dealt with in some detail. Dipping in an organic mercury preparation or 1 per cent formalin gives a good measure of control if done at lifting time, though the disadvantages of wet treatments at the busy harvest season are obvious. Thymol at the rate of 5–6 oz. (made up to 10 lb. with kaolin) per ton of potatoes has been found to be the best all-round method of control. Occasionally, however, the thymol exhibits a marked phytocidal effect on the tubers, though generally only a part of each tuber is damaged and the remainder can grow and yield normally. Application of thymol both at lifting and riddling was recommended, since these are the times of maximum damage when infection generally takes place. In the discussion which followed, the merits of the proprietary compound 'Fusarex' were discussed, together with its advantage in delaying sprouting.

J. G. HAWKES

RHEOLOGY OF MINERALS

ANNUAL CONFERENCE OF THE BRITISH RHEOLOGISTS' CLUB

THE annual conference of the British Rheologists' Club was held at Hulme Hall, University of Manchester, during September 11–13. The inaugural address was given by Prof. Harold Jeffreys, of Cambridge, who spoke on the strength of the earth; Dr. Markus Reiner, of Jerusalem, was in the chair. Prof. Jeffreys pointed out that in geophysics it is usual, as a first approximation, to assume that most of the earth is a perfectly elastic solid (transverse elastic waves from earthquakes travel freely through it to a depth of nearly half the radius, corresponding to five-sixths of the volume). Decisive evidence was given that the earth is strongly condensed towards the centre, which consists probably of liquid iron. Prof. Jeffreys discussed geological strains associated with fracture and continuous flow, and spoke on experimental work done on the behaviour of rocks under large stresses. The effective rigidity can be reduced to a half by long loading; but the fact that the Pyramids still stand is evidence that the strain tends to a finite limit. Treating the problem of fracture by dynamical methods, it can be shown that fracture can occur under the pressures existing at 650 km., the deepest earthquake focus recorded, a fact against the many theories that postulate a finite viscosity under stress differences however small. The crushing strengths of granite and basalt, as measured in the laboratory, are about 10^9 dynes/cm.^{2}. Sir George Darwin, studying a harmonic distribution of load resembling a set of parallel mountain chains, found that the stress difference would reach a maximum at a depth $\frac{1}{2}\pi$ of the wave-length and be equal to e^{-1} times the range of load; for the Himalayas, this would suggest stress differences of the order of 10^9 dynes/cm.^{2}, and the great ocean deeps could be supported by similar strengths. It is known that there are widespread disturbances of gravitational fields that are not noticeably correlated with height; these imply genuine variations of mass per unit area, and therefore of load on the lower layer, which cannot be in a hydrostatic state.

A paper on the mechanical properties of soils and their relation to engineering practice was read by A. W. Skempton, University reader in soil mechanics and assistant professor at the Imperial College of Science and Technology, London. The mechanical properties of sands, gravels, silts and clays—referred to as soils in civil engineering—are of importance in many practical problems, including foundations, earth dams, retaining walls, roads and runways. An analysis of many practical problems was given, together with a quantitative description of the main classes of soils. This was followed by an outline of our present knowledge on the shear strength characteristics, with particular reference to clays, and the various problems in which shear strength plays an essential part. The consolidation of clays was also considered, together with some of the results which have been obtained in recent researches on the electro-physical properties of clays and silts.

In the morning session of September 12, Prof. Jeffreys in the chair, papers were read by Prof. F. C. Phillips, Herdman professor of geology in the University of Liverpool, on preferred orientation of minerals and the mechanism of rock flow, and by Dr. G. M. Lees, chief geologist, Anglo-Iranian Oil Co., Ltd., on the formation of salt domes and the flowage of rock salt. Prof. Phillips in his paper pointed out that the primary flow of igneous rocks, consolidating from a melt, may frequently be traced in a linear or platy parallelism of phenocrysts or included fragments in flow layers. Unconsolidated sediments, too, may show primary flow structures in the sense that they may flow by reason of their high water content. Rocks are found folded to a degree varying from gentle flexures to the recumbent overfolds, or nappes, of mountain systems, such as the Alps, with amplitudes of many miles; these have responded to compressional stress by flowing in the sense that they have acquired a permanent deformation without loss of cohesion. Prof. Phillips discussed in detail the actual means by which rock flow is achieved, and gave evidence of dimensional and lattice orientation of individual fabric elements. The fabric of fine-grained rocks such as slates can be studied suitably by X-ray methods. The fact that in most deformed rocks some degree of preferred orientation is present suggests that at some stage a new mechanism of translation gliding operates which allows further deformation without continued rotation. This movement is similar to that in glacier motion and has been ascribed variously to the displacement of rigid masses along shear planes, to local melting and regelation, to intergranular movement and to translation gliding of the crystals.

There is good evidence for translation gliding in minerals such as mica, and twin-gliding in calcite, but there is still no certain evidence of the real mechanism by which the apparent plasticity of quartz is achieved; an artificial orientated quartz fabric has been

obtained by shearing according to Larsen and Bridgman.

Dr. G. M. Lees in his paper continued the subject of rock flow by referring to the formation of salt domes in Persia. He illustrated his talk with numerous diagrams of geological sections of the Persian oil-fields showing sinuous anticlines 100–200 miles in width, bent and folded with little fracture or faulting although the folds of limestone are 2,000 ft. thick. There was considerable discussion on the mechanism of flow in the salt masses.

There were two papers on viscometry: one by Dr. R. Schnurmann, chief physicist, Manchester Oil Refinery, Ltd., on the effect of shearing stress on the viscosity–temperature dependence of lubricating and hydraulic oils; and another, on industrial viscometers, by Dr. E. W. J. Mardles and Mr. A. G. Ward, speaking on behalf of the committee of the British Rheologists' Club in its report on the subject. Dr. Schnurmann described in detail recent experiments at high rates of shear on the shear breakdown of polymer solutions, the degradation being traced to the fissure of long-chain molecules by mechanical means. In the Committee's report on industrial viscometry, a short survey of conditions of rheological measurements, of methods and of viscometers, penetrometers, etc., was made. The principles which should govern routine measurements for non-Newtonian systems were given briefly, and it was considered that all instruments should be reviewed in the light of these principles.

Concern was expressed about the inaccuracy of some standard viscometers, in particular, orifice viscometers with diameter of orifice not much less than the length. Apart from difficulties of dribbling, lack of temperature control and lack of calibration against a master cup, the times of flow may have little or no relation to viscosity values. With some penetrometer results, it had frequently been assumed that it is possible to interpret them by the classical law of Stokes, assuming the behaviour was Newtonian; this was found not to be the case with greases, paints and thickened liquids.

In addition to visits to the Manchester Oil Refinery and to the engineering laboratories of the Metropolitan-Vickers Electrical Co., Ltd., an evening was devoted to an informal discussion opened by Dr. K. Weissenberg and Mr. S. M. Freeman (Shirley Institute, Manchester), who demonstrated some rheological phenomena that had come to light since the last conference. They dealt specially with anisotropy-time effects using elastic liquids and elastic solid/gas systems. The rheogoniometer was used to indicate relaxation in different directions.

E. W. J. Mardles

FUNCTION OF THE LYMPHOCYTE

THE function of the lymphocytes in the mammalian body has long been the subject of conjecture. Now, at last, one definite function, and a very important one, has been ascribed to them, on impressive evidence. It appears that the lymphocytes synthesize and afterwards liberate into the blood the normal γ-globulin of the plasma and also the various antibodies which appear in the blood in immunity reactions. The antibodies are known to be simply specific modifications of γ-globulin. Furthermore, it has been shown that this liberation of γ-globulin by the lymphocytes, and in fact the whole activity of the lymphoid tissue, are controlled by one of the hormones of the adrenal cortex. At a conference on lymph held by the New York Academy of Sciences in April 1945, W. E. Ehrich (*Ann. New York Acad. Sci.*, **46**, 823; 1946) and A. White and T. F. Dougherty (*ibid.*, p. 859) presented the important contributions which they have made to this new knowledge of the lymphocyte.

It has long been known that about 200 million lymphocytes per hour enter the blood stream. They must, therefore, be removed from the blood at a corresponding rate, but where or how this occurs has been a mystery. It has now been shown that, as first suggested by Heiberg in 1922, a large proportion of the lymphocytes return to the germinal centres of the lymph nodes, where they undergo a process of 'dissolution'. It is not quite clear how the lymphocytes get back to the germinal centres, but it seems probable that they emigrate directly from the blood vessels which supply the lymphoid tissue, possibly from certain venules of peculiar structure which are to be found there. The process of dissolution involves the shedding of cytoplasmic fragments by a process of budding and also, in the case of many lymphocytes, complete cellular destruction, the nuclear remains being phagocytosed by the macrophages of the germinal centre. In the process of dissolution, γ-globulin, which is presumably synthesized by lymphocytes as a normal cytoplasmic component, is liberated and is carried away in the lymph stream to the blood.

The germinal centres are thus both the birthplace and graveyard of the lymphocytes, and their main function seems to be to manufacture and carry a store of γ-globulin which is liberated and made available to the body on their dissolution. γ-Globulin is thus one of the few plasma proteins, possibly the only one, not manufactured in the liver. The antibodies of the blood, which appear during the development of immunity to foreign proteins, bacteria and bacterial toxins, are known to be specific modifications of normal plasma γ-globulin, differing only in the configuration of the molecule and the arrangement of the constituent amino-acids. It is thought that, in an immunity reaction, the lymphocytes manufacture the specific antibody in place of the normal γ-globulin, and therefore liberate the antibody instead of γ-globulin when they disintegrate in the germinal centres.

Hitherto it had been supposed that the antibodies were manufactured by the cells of the reticulo-endothelial system. This theory, due to Metchnikoff, rested chiefly on the observation that reticulo-endothelial blockade reduced antibody formation. In order to reconcile this fact with the newer knowledge, Ehrich supposes that the antigen must first be ingested and partly digested by the reticulo-endothelial cells, the digestion products then stimulating the lymphocytes to form the specific antibody. It would seem unlikely, however, that antigen could be digested far, if at all, without losing its specific antigenic properties. White and Dougherty have shown that the hormone of the adrenal cortex stimulates the dissolution of lymphocytes in the germinal centres and so increases the liberation of γ-globulin and antibodies into the blood, and also, incidentally, reduces the total volume of lymphoid tissue in the body. A single injection of adrenal cortex hormone or of the adrenotrophic hormone of the pituitary gland causes a marked increase of lymphocyte destruction in the germinal centres, a lymphopænia and a rise

in plasma globulin, the changes reaching a maximum about twelve hours after.

If an animal was first immunized to an antigen (sheep's red cells) and then some months later, when all the antibody had disappeared from the blood, injected with adrenal cortex hormone, the antibody reappeared in the blood in considerable amount. The therapeutic implications of this experiment are obvious and will no doubt be explored. It has also been shown that the total amount of lymphoid tissue present in the body is determined and controlled by the adrenal cortex, and the normal age involution of the lymphoid tissue (including the thymus) is ascribed to an increasing activity of the adrenal cortex, which is in turn due to an increasing activity of the anterior pituitary. The pituitary-adrenal mechanism for the release of γ-globulin and antibodies can be activated experimentally in a number of ways, for example, by hæmorrhage, heat, cold, X-rays, foreign proteins, injection of benzene or arsenite. From another point of view the lymphocytes of the body represent a considerable store of protein which can be rapidly released by the pituitary-adrenal mechanism in states of emergency.

Reports of a repetition of this work have not yet been published, and confirmation or otherwise of the somewhat surprising results will be awaited with interest.

O. A. Trowell

MINERAL PRODUCTION OF CANADA

"THE Canadian Mineral Industry in 1945", published by the Bureau of Mines, Ottawa (1946, pp. 103), contains reviews of the various metals, industrial minerals and fuels produced in the Dominion during 1945, and gives particulars in each case of sources of supply, uses, prices and tariffs, and figures for production, exports and imports. In order of value (stated in millions of dollars) the chief products are: aluminium (133·6); gold (103·8); coal (67·6); nickel (62); copper (59·3); zinc (33·3); platinum group (26·7); asbestos (22·8); lead (17·3); cement (14·2); petroleum (13·6); lime, limestone and marble (13·2); natural gas (12·3); sand and gravel (10·6); clay and clay products (8·3); silver (6); salt (4); peat (2); pyrite and sulphur (1·9); gypsum (1·8); silica (1·5); barite (1·3); magnesitic dolomite and brucite (1·3); granite (1·1); sodium sulphate (0·9); selenium (0·7) and cadmium (0·6). No corresponding figure for iron ore is given, but it is interesting to note that production, negligible only a few years ago, has recently increased enormously, and is expected soon to equal the requirements of the Canadian iron and steel plants. The Helen Mine, north of Lake Superior, and the Steep Rock Mine, west of Port Arthur, each produced more than half a million tons during 1945 and have very substantial reserves.

The temporary disappearance of magnesium from the above list is a symptom of war-time over-production, large stocks of the metal and its alloys having already been accumulated in Ontario. It may be a surprise to many to find aluminium at the head of the list. Although there is no bauxite in Canada, the Canadian aluminium industry is the second largest in the world, being exceeded only by that of the United States. The favouring factors are the low costs of hydro-electric power at points where the necessary raw materials can be cheaply assembled.

Canada's dominating position as a source of nickel is well known; it remains at about 80 per cent of the world total. Despite the drastic reduction in munitions manufactures, the many new uses found for nickel during the War, as in radar and extended utilization of nickel-bearing steels, are expected to provide an expanding market. Canada continued to be one of the leading exporters of copper, and to maintain its position—gained from the U.S.S.R. in 1934—as the leading producer of the platinum and palladium group of metals. Coal production is down a little and petroleum by as much as 15 per cent.

Production of oil from the Turner Valley field has been decreasing since 1942. The search for new fields in Alberta has so far been disappointing, but six producing wells have been completed in Saskatchewan, which appears as a small producer for the first time. The development of natural gas resources has been more successful, especially in Alberta. The new gas field recently discovered in Ontario beneath the floor of Lake Erie was brought into production by means of wells put down a mile from the shore.

ANALYTICAL GEOLOGY

THIS is the name given by A. B. Vistelius to the application of statistical analytical methods to numerical geological data and the subsequent interpretation of the results in the light of significant geological facts. In a series of five short articles*, he applies this method to the study of the porosity of rocks belonging to the oil-bearing strata of Permian age in the Transvolgian region of the U.S.S.R. The original data consist of a number of records of the coefficients of porosity (y) of rocks, taken in a number of bore-holes at a certain depth (x) below a definite stratigraphical horizon. Plotting the coefficient of porosity against depth, Vistelius obtains broken-line diagrams which are smoothed out so as to give continuous curves. It is then discovered that for all the bore-holes of the region these curves correspond to a definite formula, the equation of which is originally given as

$$y = m + nx + \exp(a_1x + b_1)\cos(\omega_1x - \varphi_1) + \exp(a_2x + b_2)\cos(\omega_2x - \varphi_2),$$

and then reduced to a general serial expression of the type

$$y = \sum_{i=0}^{k} \exp(a_ix + b_i)\cos(\omega_ix + \varphi_i)$$

where $k \leqslant 3$.

Then the coefficients a_i, b_i, ω_i and φ_i are calculated for each bore-hole and the analogous coefficients for different bore-holes are compared and plotted on the geographical map by means of isopleths (contour lines corresponding to equal numerical values).

The isopleth maps, showing the regional distribution of the numerical values of the coefficients of the generalized formula, are then compared to other maps such as strato-isohyps maps or isopachyte (lines of equal thickness of a bed) maps of the region, and it is discovered that the isopleth maps of certain coefficients are analogous either to structural isohyps maps or isopachyte maps. This suggests that the distribution of porosity in a sedimentary complex

* Vistelius, A. B., *Compt. Rend.* (*Doklady*) *Acad. Sci. URSS.*, **44**, No. 1, 27 (1944); **49**, No. 1, 44 (1945); **49**, No. 7, 531 (1945); **54**, No. 6, 519 (1946); **55**, No. 3, 241 (1947) (Russian text).

obeys not only a certain periodic law, as expressed by the general formula, but is also linked up with the general geological structure of the region and is therefore related to the geological history of the sedimentary complex. The coefficient of periodicity (ω) appears to be especially significant, and the isopleth maps of this coefficient can be easily correlated with either the structural maps or the isopachyte maps. According to whether the members of the equation contain the minimum, maximum or intermediate value of ω, they are called micro-, macro- or meso-rhythms.

To Vistelius all this suggests that porosity is closely related to the processes of deposition and epigenesis (cementation and leaching), and so can be used as a measure of what he calls the 'phase differentiation' of the sedimentary complex, the phases in this case being the solid phase (mineral components of rocks) and the liquid and gaseous phases (infilling the pore space). If the empirical equation of the vertical distribution of porosity is compared with the equation expressing the normal law of errors, or rather the function of distributed probabilities, one is able to get an estimate of the magnitude of the secondary processes (epigenesis) as compared with the magnitude of the primary processes (sedimentation). This is achieved by the construction of isopleth maps for kurtosis and skewness, which provide a sensitive method of discovering the distribution of 'fossilized processes'.

All this work is still in its pioneering stage and as presented can be appreciated only by geologists well versed in modern statistical methods. It is rather difficult to evaluate the significance of isopleth maps for equation coefficients when these are compared with structural contour maps (isohyps or isopachytes). In spite of this difficulty, this work appears very interesting and important. There is a suggestion that this method may have a wider applicability to geological problems in which the immediate data do not allow any direct correlation or deduction. The practical importance of the application of statistical methods to geology may be considerable. In the case discussed by Vistelius, the porosity of the rocks has a direct bearing on the distribution of reservoir beds in an oilfield, but it is not difficult to find many other instances of work of economic value in which statistical methods may have an application. Such are, for example, water supplies, distribution and grade of coal in coalfields, and other similar problems.

S. I. TOMKEIEFF

ELEMENTARY PARTICLES AND THE GEOMAGNETIC FIELD

RECENTLY J. Barnóthy[1] has proposed an explanation of the elementary particles (protons, electrons, etc.) in terms of serial universes, each enclosed in one of higher order. The elementary particles of our universe are universes of a lower order; our universe is an elementary particle in a higher universe. The universes are three-dimensional curved ones enclosed in a four-dimensional space; that of an elementary particle has a two-dimensional intersection with our universe, which delimits a region excluded from the latter. Mass in an elementary universe becomes imaginary mass ($\sqrt{-1} \times$ mass) when viewed from ours; the gravitational attraction between two imaginary masses is a real electrostatic force. The spin of an elementary universe gives parts of its mass a velocity greater than c; this makes the imaginary mass acquire real linear and angular momentum. Nuclear forces in our universe are the counterparts of cosmical repulsions in the elementary universe. Protons and electrons arise from Einstein universes of negative and positive curvature; a neutron is formed by the combination of a proton and another particle arising from a de Sitter universe.

Barnóthy expresses these general ideas in a quantitative form. Like Eddington, by some of whose ideas he has been profoundly influenced, he derives an impressive list of theoretical values of fundamental constants, in good agreement with the experimental values. One must add that, again as with Eddington, it is often difficult to trace the interconnexions between different parts of his argument. In particular, the mechanism by which internal properties of a micro-universe react on our universe is far from clear.

Barnóthy claims to explain the proportionality between magnetic moment and angular momentum of sun and earth, to which Blackett and Babcock have recently directed attention. [Barnóthy's work was not suggested by that of Blackett and Babcock; a preliminary account of his ideas, dated September 13, 1946, was received by *Nature* last year, but was not regarded as sufficiently explicit to warrant publication. EDITORS.] He asserts that protons and neutrons possess, besides their real mass, an imaginary mass 643 times the electron-mass, and this imaginary mass behaves like an electric charge. The rotation of such a charge would produce terrestrial and solar magnetic fields of just the observed order of magnitude; but the suggestion is not at present satisfactory, since such a charge would produce a formidable electrostatic field, and Barnóthy declines to consider this field for the present.

T. G. COWLING

[1] Hungarian Institute for Meteor. and Terr. Mag., Papers on Terrestrial Magnetism, No. 2 (1947).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, December 15

ROYAL PHYSICAL SOCIETY OF EDINBURGH (at the Royal Scottish Geographical Society, Synod Hall, Castle Terrace, Edinburgh), at 5.15 p.m.—Symposium on "The Species Concept".

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (in the Reynolds Hall, College of Technology, Manchester), at 5.30 p.m.—Prof. T. B. L. Webster: "Three Interpretations of Greek Vases" (Presidential Address).*

INSTITUTION OF THE RUBBER INDUSTRY, MANCHESTER AND DISTRICT SECTION (joint meeting with the SOCIETY OF CHEMICAL INDUSTRY, at the Engineers' Club, Albert Square, Manchester), at 6.15 p.m.—Dr. D. A. Harper: "The Technology of some New Condensation Rubbers".

ROYAL INSTITUTE OF CHEMISTRY, LONDON AND SOUTH-EASTERN COUNTIES SECTION (at Norwood Technical Institute, Knight's Hill, London, S.E.27), at 7 p.m.—Microchemical Exhibition and Demonstration (organised by Mr. J. T. Stock).

Tuesday, December 16

ROYAL SOCIETY OF ARTS, DOMINIONS AND COLONIES SECTION (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Mr. Colin Colahan: "Australian Art".

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Dr. F. Hepner: "Communications and History".

EUGENICS SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. J. A. Fraser Roberts and Dr. Eliot Slater: "Genetics, Medicine and Practical Eugenics".*

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, London, S.W.1), at 5.30 p.m.—Sir Charles Inglis, F.R.S.: "Mathematics in relation to Engineering, with Special Reference to a Recent Paper by the Lecturer on Shear Stress Determination".

SOCIETY OF CHEMICAL INDUSTRY, CHEMICAL ENGINEERING GROUP (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. J. G. Window: "Glass Equipment in the Chemical Engineering Industries".

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Annual General Meeting; at 6.15 p.m.—Scientific Papers.

SOCIETY OF CHEMICAL INDUSTRY, PLASTICS GROUP (joint meeting with the LONDON SECTION of the INSTITUTION OF THE RUBBER INDUSTRY, in the York Room, Caxton Hall, Westminster, London, S.W.1), at 6.30 p.m.—Dr. D. V. N. Hardy: "Terylene and its Early Development".

TEXTILE INSTITUTE, MIDLANDS SECTION (joint meeting with the COVENTRY TEXTILE SOCIETY, at the Technical College, Coventry), at 6.45 p.m.—Mr. R. Meredith: "X-Rays in relation to Textiles".

SOCIETY OF DYERS AND COLOURISTS, SCOTTISH SECTION (at the Royal Technical College, Glasgow), at 7 p.m.—Dr. C. H. Giles: "Modern Methods of Colorimetric Analysis".

TEXTILE INSTITUTE, LANCASHIRE SECTION (at 16 St. Mary's Parsonage, Manchester), at 7 p.m.—Mr. L. L. Preston and Mrs. A. N. Thomas: "Radio Frequency Heating and Infra-Red Drying".

SOCIETY OF INSTRUMENT TECHNOLOGY, NORTH-WEST SECTION (at the College of Technology, Manchester), at 7.15 p.m.—Scientific Films (arranged by Mr. H. Ogden and Mr. F. Hill).

Wednesday, December 17

BRITISH SOCIETY FOR INTERNATIONAL BIBLIOGRAPHY (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 2.30 p.m.—Papers.

CHEMICAL SOCIETY (at the Royal Institution, 21 Albemarle Street, London, W.1), at 5 p.m.—Prof. John Read, F.R.S.: "Chemical Personalities a Century Ago".

ROYAL MICROSCOPICAL SOCIETY (in the Hastings Hall, B.M.A. House, Tavistock Square, London, W.C.1), at 5 p.m.—Films.

INSTITUTE OF PHYSICS, ELECTRONICS GROUP (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. R. Kompfner: "The Travelling-Wave Tube".

BRITISH RHEOLOGISTS' Club (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 6 p.m.—Papers on "War-time Rheological Investigations for the Services".

SOCIETY OF DYERS AND COLOURISTS, MIDLANDS SECTION (in Room 104, College of Technology, Leicester), at 7 p.m.—Mr. R. R. Clegg: "Textile Drying Technique".

INSTITUTION OF THE RUBBER INDUSTRY, SOUTHERN SECTION (joint meeting with the SOUTHERN SECTION of the PLASTICS INSTITUTE, at the Polygon Hotel, Southampton), at 7.15 p.m.—Mr. S. B. Turner: "Expanded Plastics".

SOCIETY FOR VISITING SCIENTISTS (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Discussion on "Science and Fuel" (to be opened by Prof. D. M. Newitt, F.R.S., and Dr. Martin Ruhemann).

Thursday, December 18

INSTITUTION OF MINING AND METALLURGY (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. F. H. Fitch: "The Tin Mines of Pahang Consolidated Co., Ltd.".

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. G. K. Batchelor: "Progress and Difficulties in the Theory of Isotropic Turbulence".

PHYSICAL SOCIETY, LOW-TEMPERATURE GROUP (in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 4.30 p.m.—Second Annual General Meeting; at 5 p.m.—Discussion on "Insulating Materials and Methods for Use at Low Temperature" (to be opened by Prof. F. E. Simon).

ROYAL AERONAUTICAL SOCIETY (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Prof. A. Thom and Mr. W. G. A. Perring: "The Work of the High Speed Tunnel".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Discussion on "Infra-Red Spectra and Molecular Structure" (to be opened by Dr. H. W. Thompson, F.R.S.).

Friday, December 19

PHYSICAL SOCIETY (in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Sir Edward Appleton, F.R.S.: "Geomagnetism and the Ionosphere" (Fourth Charles Chree Address). (Fellows of the Royal Astronomical Society are invited.)

INSTITUTE OF INDUSTRIAL ADMINISTRATION, MANCHESTER CENTRE (in the Reynolds Hall, College of Technology, Manchester), at 7.15 p.m.—Sir Francis Joseph, Bart.: "Management and Recovery".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

BIOCHEMIST to St. James's Hospital—The Medical Officer of Health, Public Health Department (Hospitals Administration Section), 12 Market Buildings, Vicar Lane, Leeds 1 (December 20).

TECHNICAL ASSISTANT (preferably a woman) for Cod Liver Oil (Poultry) Standardization Laboratory, for work mainly connected with routine biological tests of vitamins and other substances—The Secretary, National Institute for Research in Dairying, Shinfield, Reading (December 20).

MACHINERY RESEARCH OFFICER for duties in connexion with the use and development of mechanical appliances in forestry—The Secretary, Forestry Commission, 25 Savile Row, London, W.1 (December 20).

LECTURERS IN (a) PHYSICS with subsidiary Mathematics, Ref. A.435/47A, (b) Electrical and Mechanical Engineering, Ref. D.378/47A, (c) Mechanical Engineering Drawing, Ref. C.733/47A, by the Ministry of Supply School of Electronics, Malvern—The Ministry of Labour and National Service, Technical and Scientific Register, Room 669, York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (December 23).

PRINCIPAL RESEARCH OFFICER, and a SENIOR RESEARCH OFFICER, in the Research Unit of the Colonial Insecticides Committee at Porton, Salisbury—The Under-Secretary of State (Research Department), Colonial Office, Palace Chambers, Bridge Street, London, S.W.1 (December 29).

ASSISTANT ANALYST (male) in the County Chemical Laboratory, Stafford—The Clerk to the County Council, County Buildings, Stafford (December 29).

LECTURER IN MATHEMATICS—The Registrar, University College, Leicester (December 31).

ASSISTANT DIRECTOR—The Director, The University Observatory, Cambridge (December 31).

LECTURER IN CHEMISTRY—The Secretary, Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh (December 31).

SENIOR LECTURER (or LECTURER) IN PHYSICS in Natal University College, Pietermaritzburg—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (December 31).

LECTURER IN AGRICULTURAL ENGINEERING in Canterbury Agricultural College, New Zealand—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (December 31).

SENIOR RESEARCH OFFICER or RESEARCH OFFICER IN THE DIVISION OF FOOD PRESERVATION AND TRANSPORT, Homebush, N.S.W.—The Secretary, Australian Scientific Research Liaison Office, Australia House, Strand, London, W.C.2, quoting No. 1467 (January 3).

SENIOR RESEARCH OFFICER IN THE DIVISION OF AERONAUTICS, Melbourne—The Secretary, Australian Scientific Research Liaison Office, Australia House, Strand, London, W.C.2, quoting No. 1473 (January 3).

LECTURER (with qualifications in electronics) IN THE FLUID MOTION LABORATORY—The Registrar, The University, Manchester 13 (January 31).

I.C.I. RESEARCH FELLOWSHIPS IN BIOCHEMISTRY, CHEMISTRY, ENGINEERING, PHARMACOLOGY or PHYSICS—The Secretary of University Court, The University, Glasgow (March 31).

I.C.I. RESEARCH FELLOWSHIPS IN BIOCHEMISTRY, CHEMISTRY, CHEMOTHERAPY, ENGINEERING, METALLURGY, PHARMACOLOGY, PHYSICS and allied subjects—The Academic Registrar, University of London, Senate House, London, W.C.1 (April 30).

TURNER AND NEWALL RESEARCH FELLOWSHIPS IN ENGINEERING, INORGANIC CHEMISTRY or PHYSICS, or any allied science—The Academic Registrar, University of London, Senate House, London, W.C.1 (April 30).

SOIL LABORATORY ASSISTANT by the Government of Northern Rhodesia for the Public Works Department—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.18396.

RESEARCH ASSISTANT IN BIOCHEMISTRY—Prof. E. J. King, Postgraduate Medical School of London, Ducane Road, London, W.12.

LECTURER IN MATHEMATICS—The Director of Education, The Polytechnic, 309 Regent Street, London, W.1.

TECHNICIAN (Grade B) for research laboratory of biochemistry and physiology in relation to mental disorder—The Physician Superintendent, Runwell Hospital, Wickford, Essex.

LABORATORY TECHNICIAN for physiological laboratory in the Department of Zoology—The Secretary, University Museum, Oxford.

SENIOR LABORATORY STEWARD IN THE PHYSICS DEPARTMENT—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1.

LECTURER IN PHYSICS—The Clerk, Northern Polytechnic, Holloway, London, N.7.

PHYSICIST, PHYSICAL CHEMIST (2), an ORGANIC CHEMIST, and a TEXTILE TECHNOLOGIST—The Acting Secretary, British Rayon Research Association, Bridgewater House, 58 Whitworth Street, Manchester 1.

TECHNICAL INDEXER (woman) in the PLANT AND ANIMAL PRODUCTS DEPARTMENT—The Establishment Officer, Imperial Institute, South Kensington, London, S.W.7.

LABORATORY TECHNICIAN (Grade C) IN THE PHYSICS DEPARTMENT—The Warden and Secretary, Royal Free Hospital School of Medicine, 8 Hunter Street, London, W.C.1.

PHYSICISTS OR PHYSICAL CHEMISTS, and TECHNICAL ASSISTANTS with some experience, preferably, in the clay industries—The Director of Research, British Refractories Research Association, Mellor Laboratories, Hanley, Stoke-on-Trent.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Other Countries

Caribbean Commission: Committee on Agriculture, Nutrition, Fisheries and Forestry of the Caribbean Research Council. Crop Inquiry Series, No. 3: Grain Crops in the Caribbean. Pp. xi + 125. (Port of Spain: Caribbean Research Council, 1947.) [273

Hypnotism, a Psychic Malpractice. Pp. 28. (Los Angeles and London: Theosophy Co., n.d.) 25 cents. [273

New Zealand: National Art Gallery and Dominion Museum. Report of the Board of Trustees for the Year ended 31st March 1946. Pp. 14. (Wellington: Government Printer, 1946.) 6*d*. [273

Transactions of the San Diego Society of Natural History. Vol. 11, No. 3: An Undescribed Race of the Mangrove Warbler from Baja California, Mexico. By A. J. van Rossem. Pp. 49–52. (San Diego, Calif.: San Diego Society of Natural History, 1947.) [273

Smithsonian Institution: United States National Museum. Report on the Progress and Condition of the United States National Museum for the Year ended June 30, 1946. Pp. iii + 113. (Washington, D.C.: Government Printing Office, 1947.) 30 cents. [313